Metal Finishing

POLISHING AND BUFFING · BARREL FINISHING · CLEANING
PLATING · ANODIZING · RUST PROOFING · LACQUERING & ENAMELING

AUGUST, 1961

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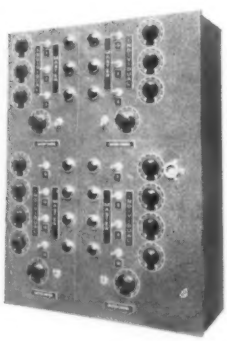
Read and pass on—

PLATING POWER BY DC POWER SPECIALISTS

SPECIALIZATION

is a big word at RAPID ELECTRIC

Mathematical Design from Scripta Mathematica



Because we at RAPID specialize in dc power supplies and their controls *you* get an entire line of standard models to choose from, plus the individual attention you require for custom requirements.

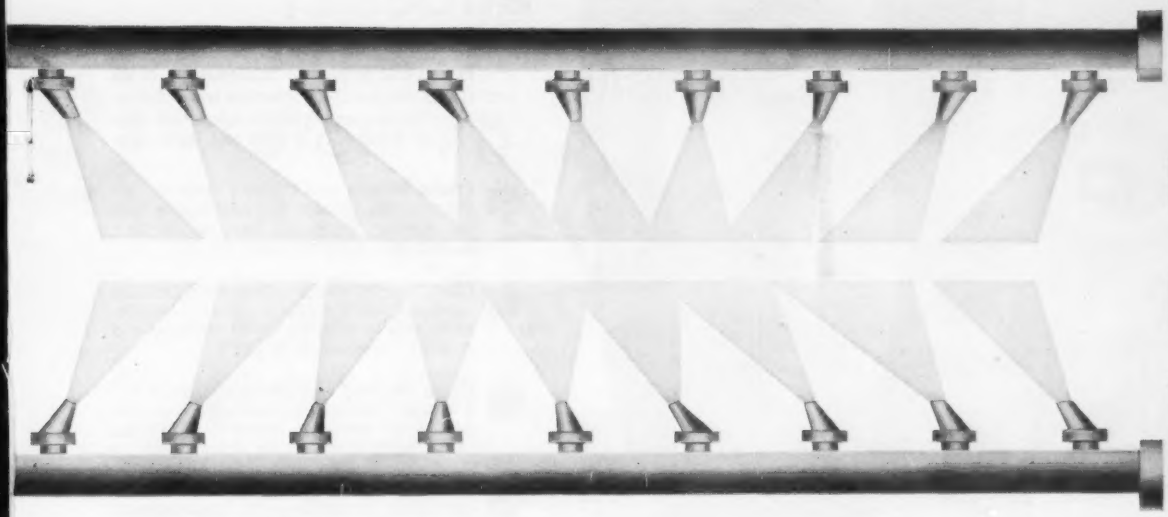
No one knows better than we, that power requirements and controls vary to individual processes. That's why we at RAPID provide a full range of controls, from standard tap switch to automatically stabilized units—*programmed* to your needs.

Before you buy your next rectifier why not consult with your local RAPID distributor (name available upon request) you'll find you'll save time and money by purchasing the right equipment for your needs.

RAPID ELECTRIC CO., INC.

2881 MIDDLETOWN ROAD • NEW YORK 61, N.Y. • TAlmadge 8-2200
PLANTS: (4) NEW YORK, N.Y. • GRAYSBRIDGE ROAD, BROOKFIELD, CONN.

spray wash clean



with new low-foam SPREAN

SPREAN 66

In new Sprean 66, excessive foaming has been eliminated without sacrificing cleaning ability. The head of foam in the reservoir tank seldom exceeds 1/2" in height — even when high pressures are used. Sprean 66, a high detergency, alkaline compound for cleaning steel, copper, brass and aluminum, has this unsurpassed combination of advantages:

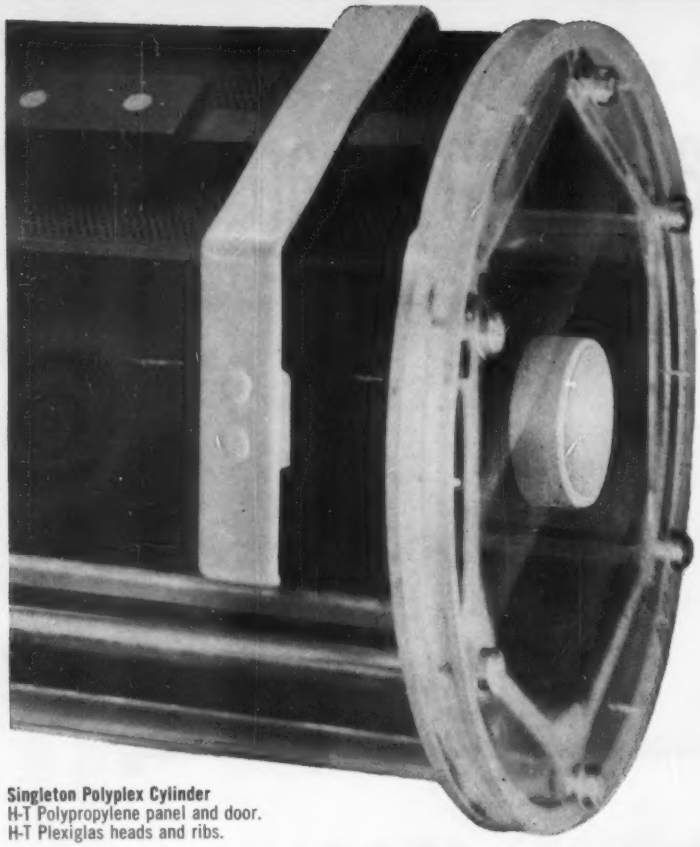
- **Low, constantly controlled foam level.**
- **Removes difficult drawing compounds, oil, solid dirt, shop soil.**
- **Inhibits rust on steel parts.**
- **Prevents scale build-up on tank walls, pipes, nozzles, steam coils.**
- **Free flowing, non-dusting, excellent detergency.**
- **Effective in all equipment: pressure spray, cylindrical screw conveyor, agitated basket-type.**
- **Cleans a variety of different metals.**
- **Has long life, is economical to use.**

To increase the efficiency and economy of your spray wash cleaning operations, write today for complete information on Sprean 66 and the name of your Enthone representative to: Enthone, Inc., 442 Elm Street, New Haven 8, Connecticut.

ANOTHER PRODUCT OF *Enthonics* RESEARCH

ENTHONE

A Subsidiary of American Smelting and Refining Company ASARCO



Singleton Polyplex Cylinder
H-T Polypropylene panel and door.
H-T Plexiglas heads and ribs.

they can't beat the Champ!

It's "no contest." The best plating cylinders other "makes" can produce are no match for a **Singleton.** Platers have proved this for themselves. In the most critical and punishing thru-cycle barrel plating, Singleton Replacement Cylinders out-perform them all **consistently . . . at lower cost.** Here's why:

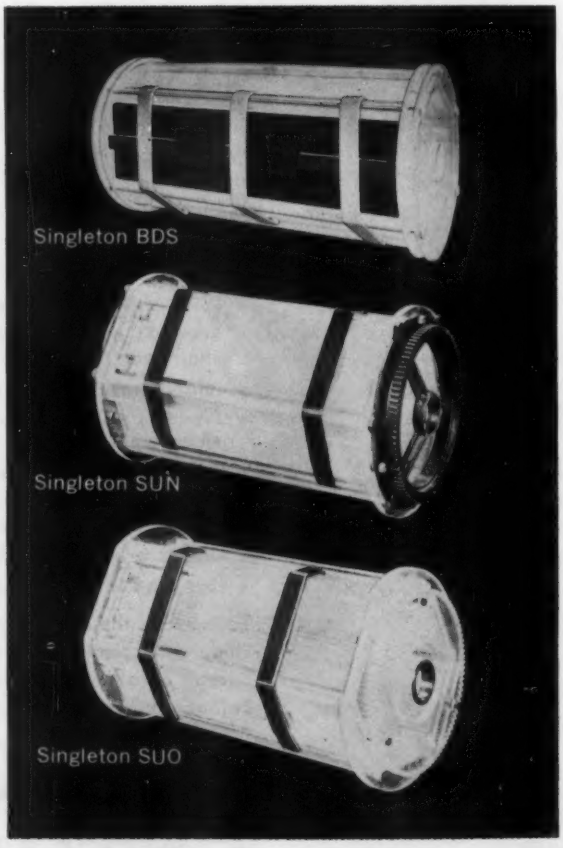
- **Greater Strength** — Singleton's exclusive "All-Bolted" heavy, "Trussed-Rib" construction. Built like a bridge. Bigger pay loads (to 350 lbs.). Longer, heavier-duty service.
- **Chem-Temp-Resistance** — Singleton's exclusive component combinations of modern hi-performance synthetic materials for all solutions, acid or alkali. Temperatures to 220°F.
- **Plating Efficiency** — Singleton's exclusive uniform panel hole pattern. More perforations per inch—better circulation. Bussed for 1420 amps. Faster, higher quality plating at lower cost.
- **Less Maintenance**—Singleton's exclusive 100% interlocking replaceable parts. Interchangeable in any combination. Do-it-yourself with only a ½" wrench and pliers. No "outside" delays. Less down-time.

Singleton Replacement Cylinders Fit Your Existing Installations — Any Make, Type, Size, Age!

Here's the easiest, lowest-cost way to optimize your barrel plating, boost productivity and earnings. Increase your output 20% and more; get easily 50% longer, trouble-free service (platers' reports on request). Convert to Singleton Replacement Cylinders and bring your barrel lines up to an immediate all-time peak in operating efficiency. Make it a "grand slam" changeover for best results, or a cylinder-at-a-time; you name it. Choose from All-Bolted or All-Welded models in H-T Plexiglas, H-T Polypropylene, H-T Tempron, H-T Seilon; or combination units — Templex, Polyplex, Seiplex, Polytemp, and others. The **right** combinations of hi-performance synthetic materials in heads, ribs, panels and doors will work wonders for your individual processing requirements. Get all the facts on: **Singleton Replacement Cylinders** to fit all makes, types, sizes, ages of superstructures. **Singleton Cylinder-Superstructure Units** to fit existing installations — any make, type, size, age. **Singleton "Cogged-V-Belt" Drive (or gear) Plating Barrels,** single or multi-station, allied equipment and accessories. These and others are featured in the new Singleton General Bulletin. Includes data, prices, etc. Send for it.

All features of this equipment are covered by Singleton's U. S. Pat. 2,886,505.

Ask about new, money-saving "special deal".



Singleton

Please contact **The Singleton Co.**, 11720 Berea Rd., Cleveland 11, Ohio.
Telephone: CLearwater 1-5580.

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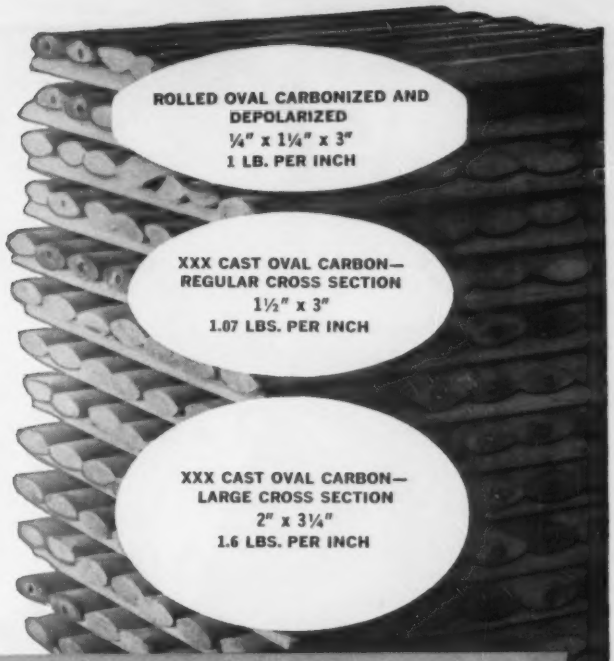
Many reasons for ordering

HARSHAW QUALITY NICKEL ANODES



ROLLED OVAL CARBONIZED AND DEPOLARIZED
¼" x 1¼" x 3"
1 LB. PER INCH

XXX CAST OVAL CARBON—REGULAR CROSS SECTION
1½" x 3"
1.07 LBS. PER INCH

XXX CAST OVAL CARBON—LARGE CROSS SECTION
2" x 3¼"
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✻ Consistent guaranteed quality ✻ Cut to any length
✻ 5 shapes to choose from ✻ High purity
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✻ Anodes arrive clean and easy to handle
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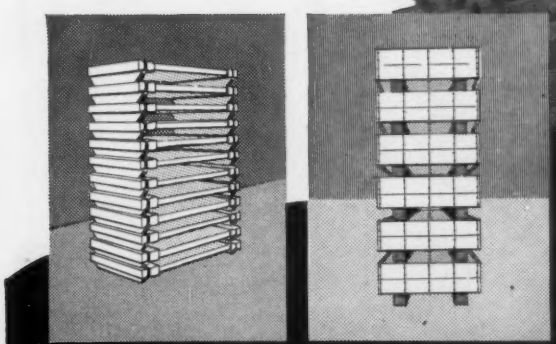

Sketches illustrate "Anopax" stacking.

ROLLED FLAT CARBONIZED—LARGE CROSS SECTION
1¼" x 4"
1.5 LBS. PER INCH

XXX CAST RECTANGULAR CARBON—LARGE CROSS SECTION
1½" x 3⅛"
1.5 LBS. PER INCH

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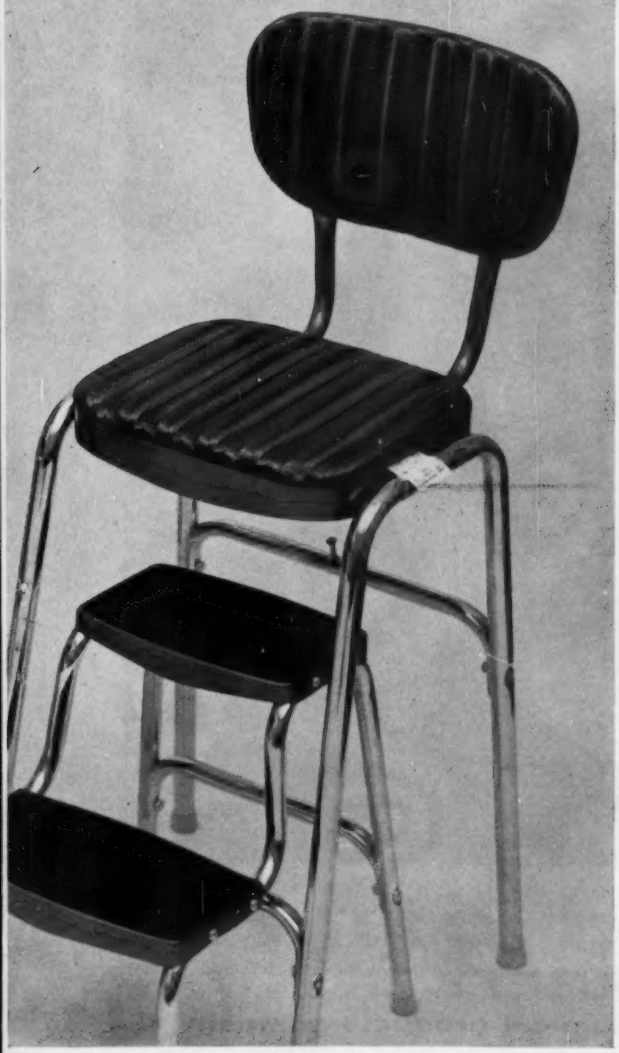
THE HARSHAW CHEMICAL CO.

1945 East 97th Street Cleveland 6, Ohio
HARSHAW
Phone RAndolph 1-8300

SHOP BULLETIN F60-17
Discontinuation
Polishing & Buffing Operations
August 8, 1960
Effective immediately all polishing and buffing operations on AMES MAID items, prior to plating, are to be discontinued.
C.D. Memel

Ames said goodbye completely to polishing and buffing when SUPERLUME came along

Ray Schlotterbeck exhibits a few Ames products plated with Superlume. Above him, another testimonial to Superlume's superiority . . . Shop Bulletin F60-17.



Reports RAY SCHLOTTERBECK,
Plating Superintendent for the world's largest maker of Shovels and Garden Tools (since 1774), as well as famous AMES MAID and AMES AIRE Tubular Furniture.

One month after Superlume bright nickel bath went into operation at O. Ames Company, Parkersburg, W. Va., the official bulletin shown declared *all* polishing and buffing there no longer necessary.

Ames had been polishing 5000-6500 parts a day, first switched to Superlume just to give its products added eye-appeal. When Superlume produced a greater depth of color *without* polishing than previous baths gave *with*, Ames got a tremendous bonus: *A reduction in its over-all finishing costs of 10 to 12%.*

"I never saw a bath that levels better," says Ray Schlotterbeck, "nor one that throws or brightens better, either." And Ames sales people add, "Our product quality was never higher."

Results like these are common with Superlume. Ask H-VW-M for full details.

H-VW-M

Progress in metalfinishing through advanced processes • equipment

Hanson-Van Winkle-Munning Company, Matawan, New Jersey
Offices in Principal Cities
Alert Supply Company is H-VW-M in the West
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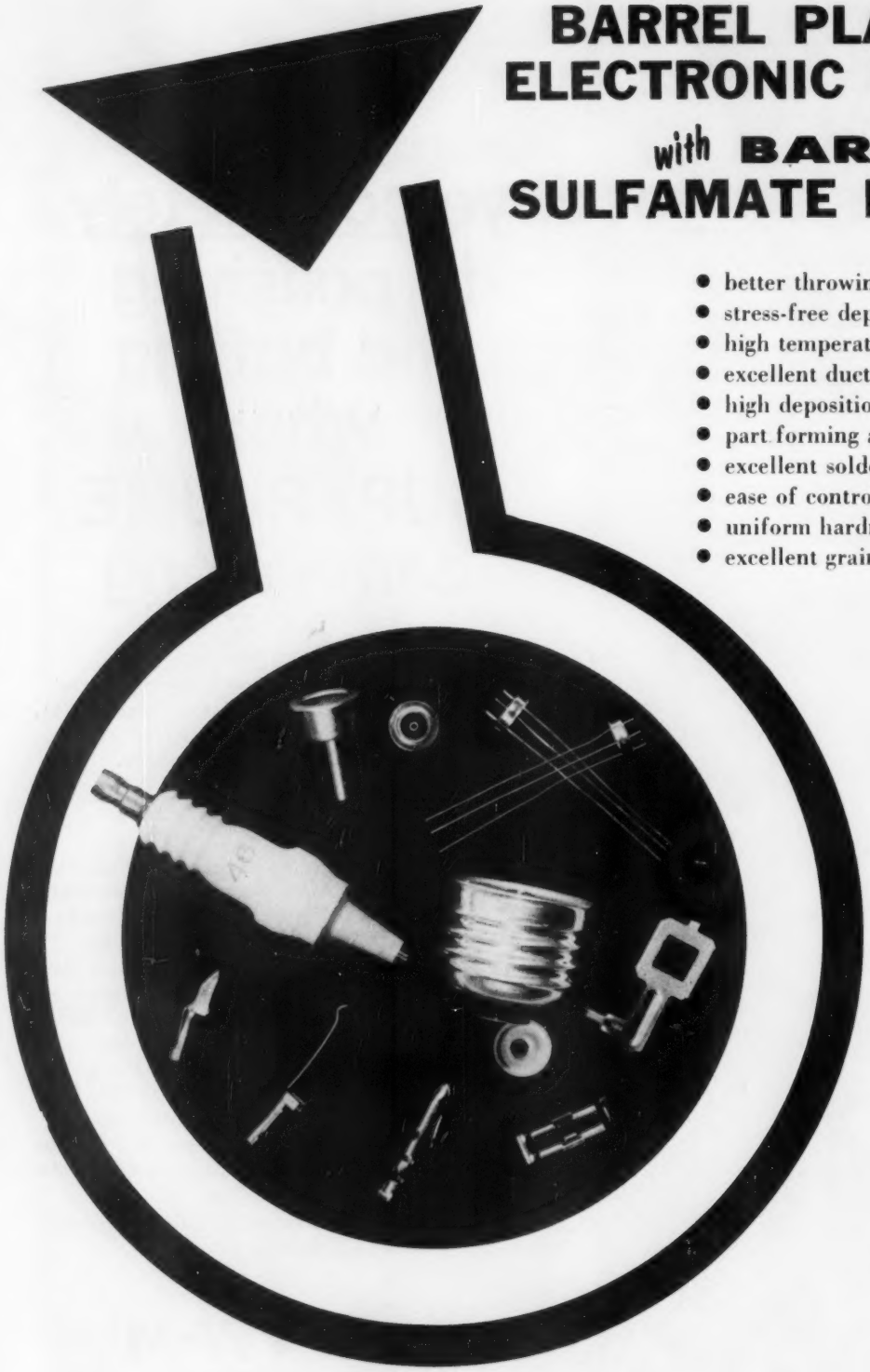
BARREL PLATE ELECTRONIC PARTS

with BARRETT SULFAMATE NICKEL

- better throwing power
- stress-free deposit
- high temperature protection
- excellent ductility
- high deposition rate
- part forming after plating
- excellent solderability
- ease of control
- uniform hardness
- excellent grain structure



● *Request Bulletin SNB-1*

Shelton, Connecticut

BARRETT
chemical products company, inc.

DAW JUNIOR

FULLY AUTOMATIC PLATING MACHINE

(Furnished For Rack Or Finger Type Plating)

Unloads Automatically Only plating machine in the industry that unloads racks or fingers without operator's attention.

Selective Cycling Automatic by-passing of tanks—or any combination of cycles—can be arranged on the Daw Jr.

Minimum Dragout Cam lift, between tank transfers, tilts work above horizontal which practically eliminates dragout regardless of workpiece shape or size.

Machine Modifies Easily Quick removal or addition of tank-and-carrier sections shortens or lengthens machine to suit any need.

Installs Anywhere Daw Junior fits in any unusual or limited floor space, and where head-room is lowest.

Fast And Economical The most versatile, most efficient machine ever designed for fast, low-cost plating of small and medium size parts.

Ask For Catalog

AUTOMATIC UNLOADING

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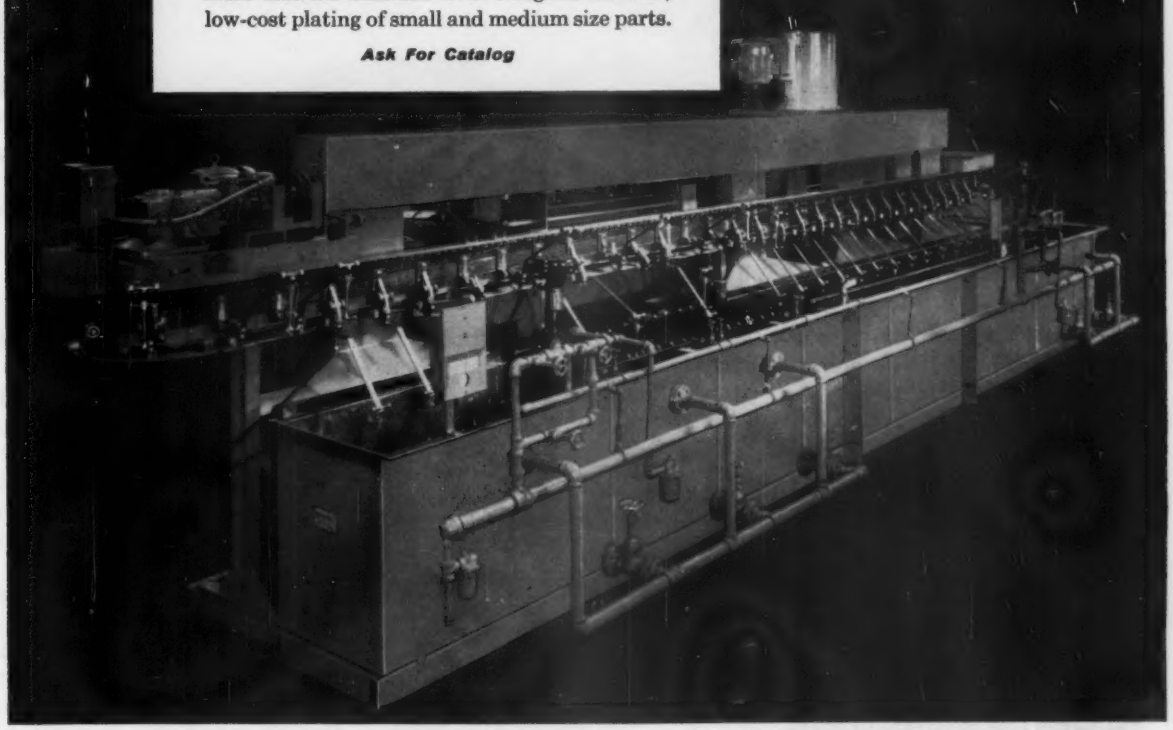
AUTOMATIC CYCLE SELECTION



LASALCO, INC.

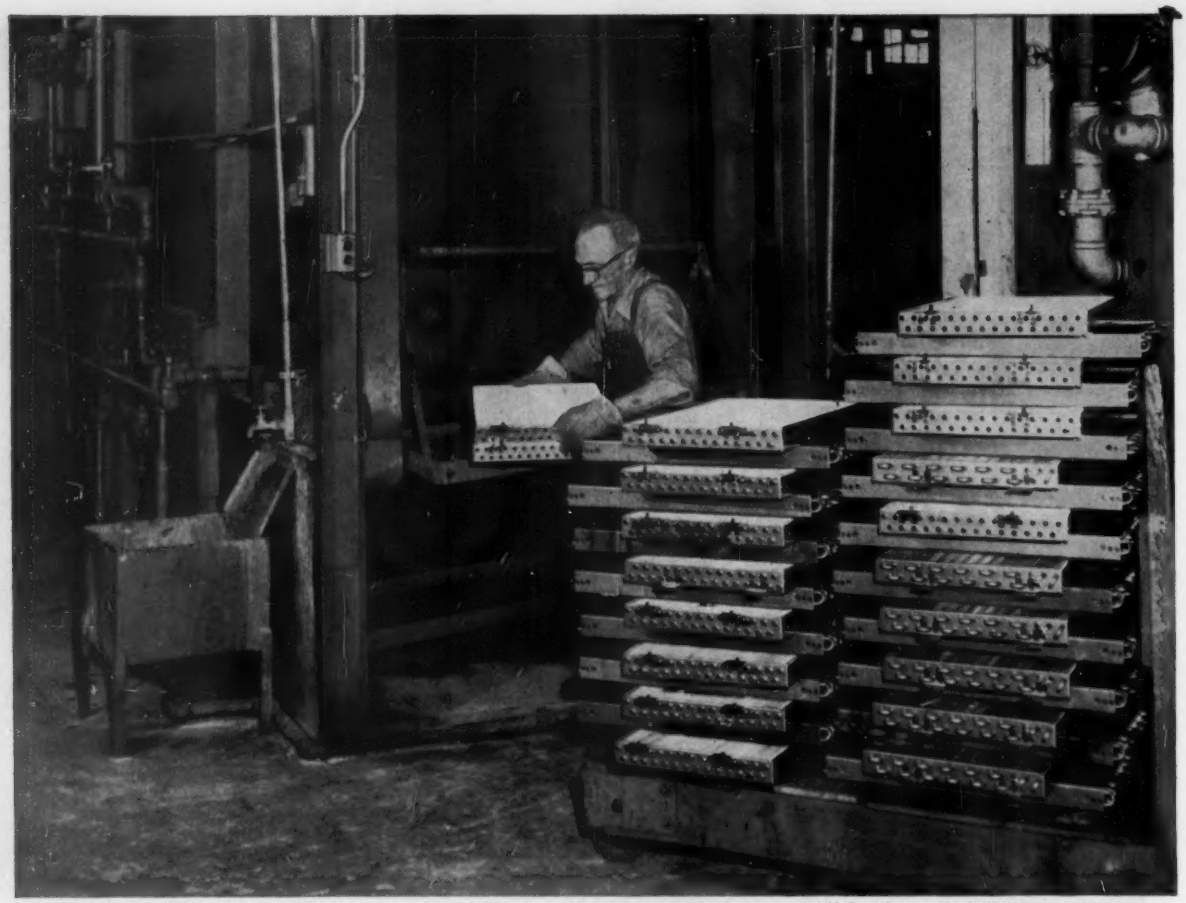
HOME OFFICE: 2820 LaSalle St. • St. Louis 4, Mo. • PRospect 1-2990
IN TEXAS: 2805 Allen St. • Dallas, Texas • Riverside 7-8093

ATTACH TO COMPANY LETTERHEAD

Send complete information on Daw Jr. Automatic Plating Machine

Name.....

Title.....



At the end of a Nialk TRICHLOR vapor degreasing cycle, operator lifts clean units from conveyorized degreaser at McCord Corporation's Washington, Indiana plant.

HOW McCORD DEGREASES 57,000 PARTS BETWEEN CLEANOUTS

Oil, grease, and metal chips clinging to condenser and evaporator units create a complex cleaning problem for McCord Corporation.

Yet McCord degreases 57,000 units with Nialk® TRICHLORethylene before cleanout.

The bath doesn't go acid, even with metal chips in it. That's because the stabilizer has *psp*—permanent staying power. In more than five years of degreasing with Nialk TRICHLOR, McCord has never had to titrate or make any similar test.

"I don't see how you could find anything more appropriate to our type of operation," says Frank McDonald, plant foreman. "Nialk TRICHLOR is fast and efficient."

Ray B. Preston (left) of the P. B. & S. Chemical Company, the local Nialk TRICHLORethylene distributor, and McCord Corporation's plant manager, John C. Padden, discuss critical cleaning requirements.

Besides being pleased with the large volume of material degreased between cleanouts, Mr. McDonald has found "the help of the Hooker people in the operation of our degreaser of great benefit to us."

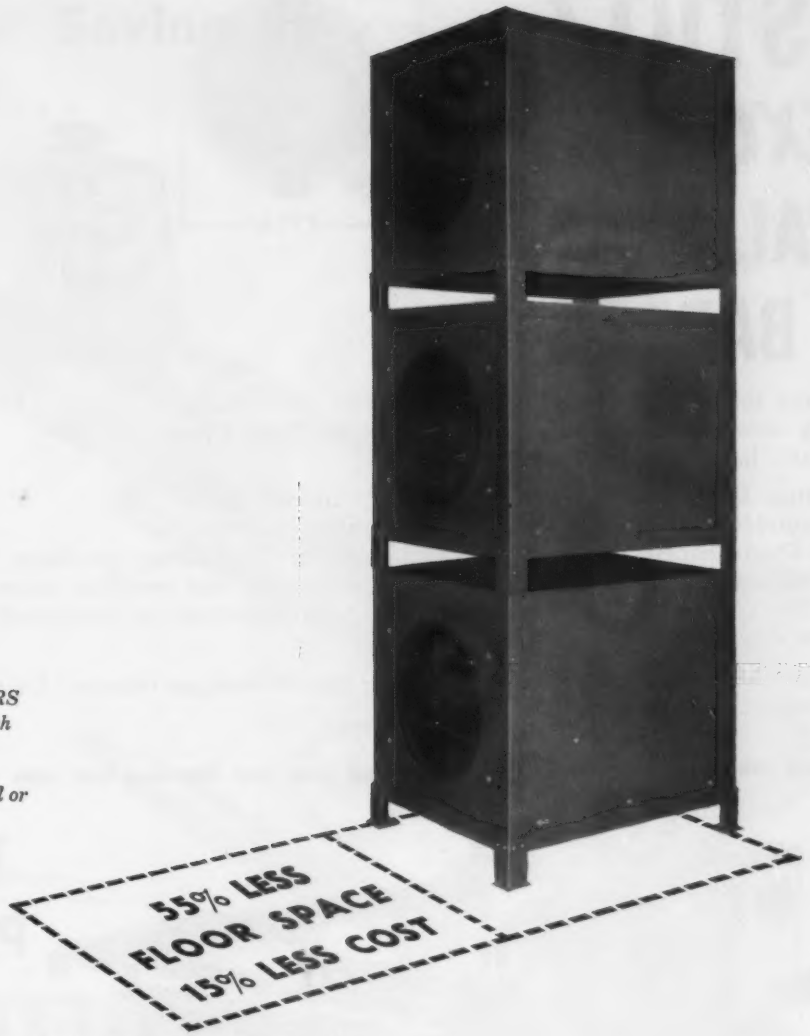
Whatever your metal, whatever your degreasing job, you can solve your cleaning problem with Nialk TRICHLOR. See your chemical distributor or drop us a line. Hooker experience is yours for the asking.

HOOKER CHEMICAL CORPORATION

1308 UNION STREET, NIAGARA FALLS, NEW YORK

HOOKER CHEMICALS PLASTICS

Sales offices: Buffalo, Chicago, Detroit, Los Angeles, New York, Niagara Falls, Philadelphia, Tacoma, Worcester, Mass. *In Canada:* Hooker Chemicals Limited, North Vancouver, B.C.



ALLIED RESEARCH
COMPACT RECTIFIERS
3000 amperes—12 volts each
Size: 34" x 34" x 46"
Total height: 114"
Available with conventional or automatic controls

FOR SALE:

Full performance in a compact size rectifier

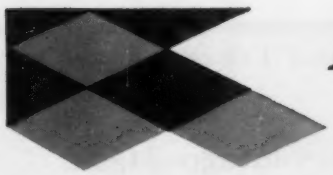
1000, 3000, 12,000, 20,000—whatever the amperage you need, you save valuable floor space and money by using Allied's Compact Silicon Rectifiers.

What's missing from Allied's Compacts? Nothing but expensive hot air. What's in it for you? Extra diodes, plenty of copper and big, rugged transformers to give full-size performance . . . all in a smaller cabinet to save you money.

But, this isn't the full value story. We know that when a rectifier stops, so do your profits. So, we've also included a new, efficient cooling system and exclusive protective devices to cut downtime and increase rectifier life.

You can build your own capacity with Allied Compacts. Use any combination of 1000 to 3000 ampere building block units side by side or stacked up to meet present or future needs.

Get full details on Allied Compact Rectifiers from your Allied representative today. He's listed in the Yellow Pages under "Plating Supplies". Or, write direct.



Allied Research Products, Inc.

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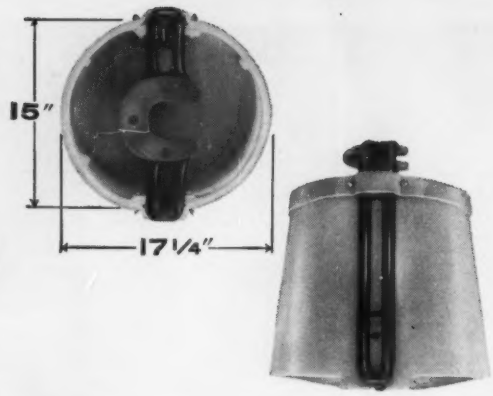
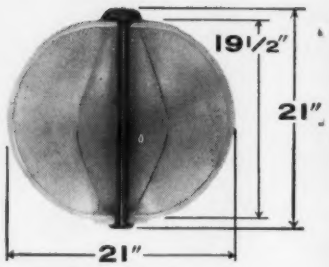
Affiliated operations in principal countries

STUTZ
EXCLUSIVE
OVAL-SHAPED
BARREL

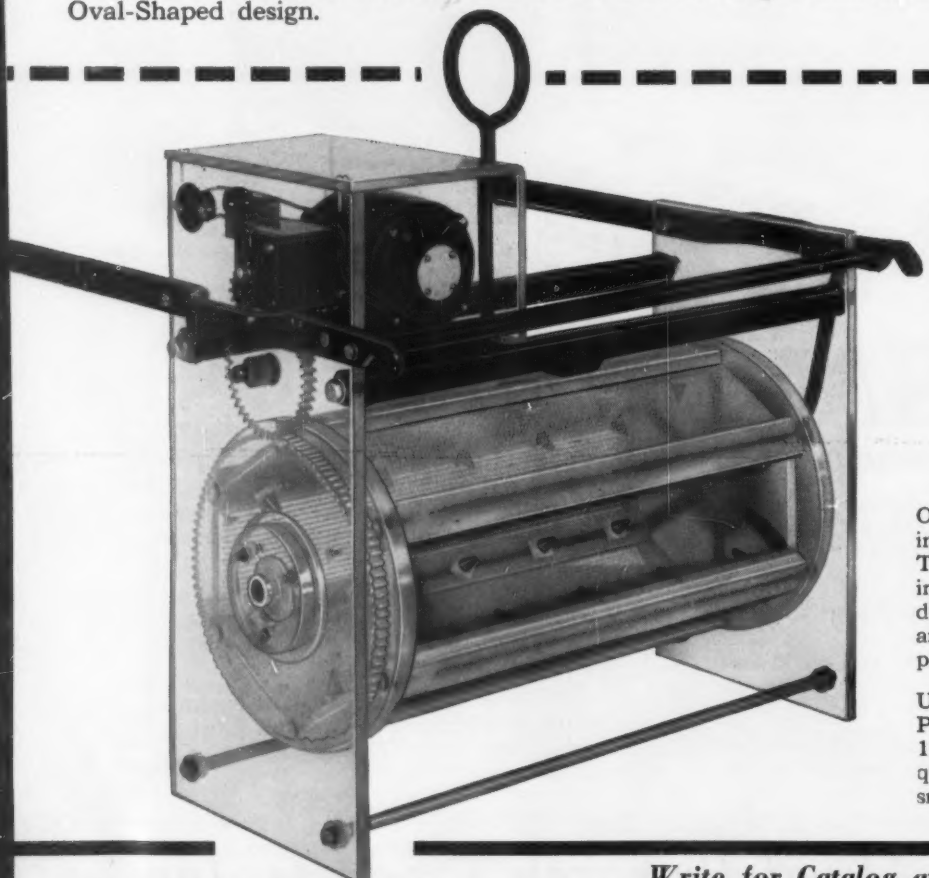




Stutz, the leader in Barrel Plating Equipment, presents an entirely new *Oval-Shaped Barrel* for use on Tub Type automatic barrel plating machines.

The Stutz Barrel, constructed of virtually indestructible *Polypropylene,* or *Linear Polyethylene* material, has a unique Oval-Shaped Top and a Convex Bottom. This design produces more convenient loading and unloading, greater load capacities and resulting increased production. The special design reduces dragout to a minimum as compared to previous obsolete designs.

Every user of this new barrel will vouch for the advantages received from this unique Oval-Shaped design.



PORTABLE
Plating Barrel
with
CONE BUTTON
CONTACTS

Offered for the first time, a Portable Plating Barrel with Cone Button Contacts. This type contact produces a perfect plating job on small delicate parts without distorting the parts. Barrel is of loose rib and panel design for easy replacement of parts, when necessary.

Units available in high temperature Plexiglas in either 6" x 12" I.D. or 8" x 18" I.D. sizes. Also special sizes upon request. Standard perforations are 3/32", smaller or larger openings are available.

Write for Catalog and Prices

The STUTZ Company

4430 West Carroll Ave. Chicago 24, Ill.

Serving Industry Over 40 Years

Looking For Savings? Then Read . . .

Lockheed F-104A Starfighter with aluminum surfaces protected by Iridite 14-2.

How IRIDITE® Helps Lockheed Cut Aluminum Finishing Costs

Nine years ago, Lockheed switched from anodizing to Iridite chromate conversion coatings. That year, they saved over $40,000 in materials and manpower.

Today, Lockheed is still saving money with Iridite 14–2. Here's how:

Process time is reduced from 45 minutes to a maximum of only 5 minutes. Three times as much work is processed in a single run. Easy-to-load baskets, replacing costly anodizing racks, save $15,000 per year. Expensive electrical equipment is eliminated because Iridite is a simple chemical dip.

Moreover, Iridite 14–2 gives improved corrosion resistance, easily meeting MIL–C–5541, and provides excellent paint adhesion.

More than likely, Iridite can save you money and give you better finishing results than your present method. Discuss it with your Allied Field Representative. Or, write for literature.

Allied Research Products, Inc. 4004-06 EAST MONUMENT STREET • BALTIMORE 5, MARYLAND
BRANCH PLANT: 400 MIDLAND AVENUE • DETROIT 3, MICHIGAN
West Coast Licensee for Process Chemicals: L. H. Butcher Co. • European Agent: Stora Granberger, Stargatan 10, Stockholm, Sweden

Chemical and Electro chemical Processes, Anodes, Rectifiers, Equipment and Supplies for Metal Finishing

IRIDITE® Chromates | IRILAC® Coatings | ISOBRITE® Brighteners | ARP® Supplies | WAGNER Equipment

MEMO

TO– *All spray phosphating engineers*

SUBJECT– *Precleaning eliminated*

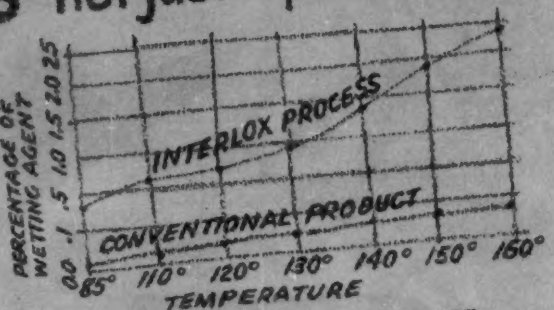
Northwest's Interlox Spray Process now assures high efficiency phosphate coatings, without precleaning, even at low temperatures.

The Interlox Spray Process has proved its superiority through more than three years of research, two years of field testing, in over 100 production installations on everything from auto parts and metal furniture to lighting fixtures and scientific instruments.

A PROCESS–not just a product !

CHECK THESE ADVANTAGES

- ✓ No alkali carry-over.
- ✓ Lower maintenance costs.
- ✓ No loose coating, (white powder or smut).
- ✓ Lower operating temperatures.
- ✓ Fewer plugged nozzles.
- ✓ Less hard scale.
- ✓ No flash rusting.
- ✓ Better smut removal.
- ✓ Less control time required.
- ✓ Complete removal of oxidized oils.



The method is simple, no complicated controls or expensive ingredients. A specially developed neutral cleaner is added DIRECTLY to the phosphate bath in whatever proportion is indicated by requirements. Maximum wetting without foam, is an accomplished fact and a fine-grained phosphate deposit is the result.

Northwest's consulting engineers will gladly survey your operation and submit recommendations. No obligation.

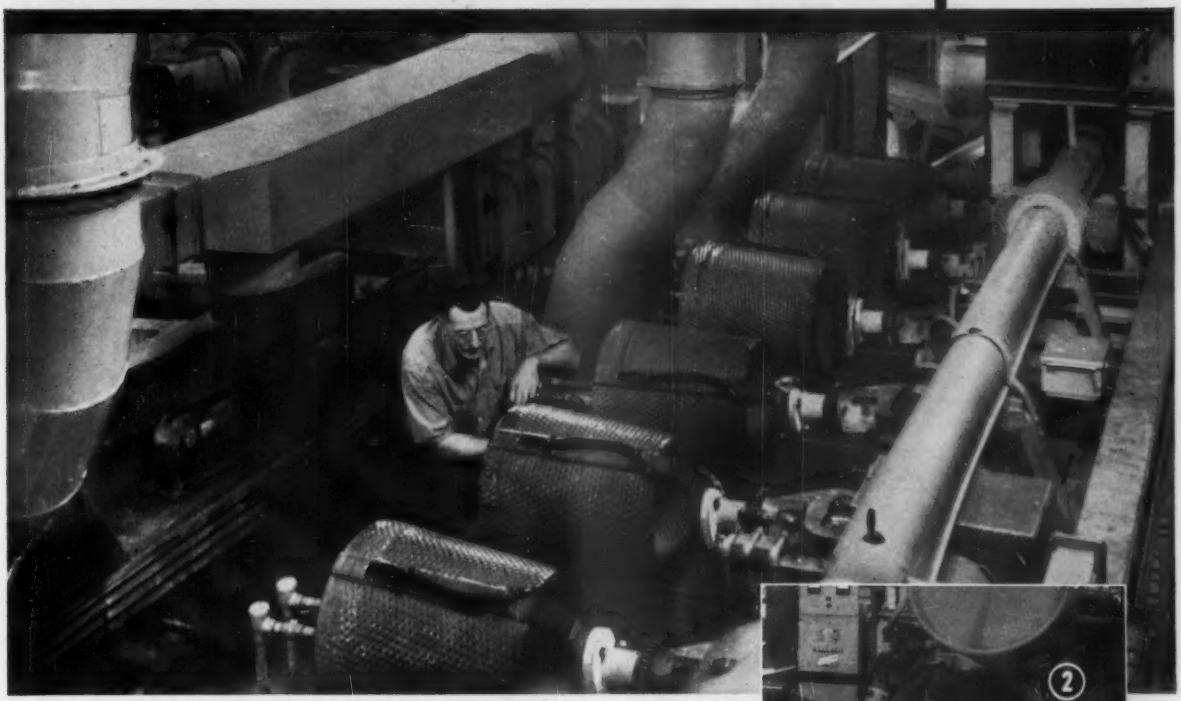
Licensed Manufacturers: ALERT SUPPLY CO. Los Angeles, Calif. • ARMALITE COMPANY, LTD. Toronto, Canada

NORTHWEST CHEMICAL COMPANY

9310 ROSELAWN • DETROIT 4, MICHIGAN

CHEMICAL PRODUCTS DIVISION • CHEMETRON CORPORATION

STEVENS helps triple plating production per man at INTERNATIONAL HARVESTER



Stevens Automatic Barrel Machine eliminates plating backlog, increases production, lowers costs.

Installation of a Stevens Model C Automatic Barrel Machine has tripled production-per-man on the zinc plating operation at the West Pullman Works of the International Harvester Company.

The completely automatic operation of the Stevens Model C has reduced the number of operators from two to one on each shift, while the overall production rate has risen 50%. Automatic loading, unloading and built-in drying, plus extreme simplicity of control, keep labor requirements at a minimum. Normal production flow is maintained on several thousand types of fasteners, bolts and nuts for this world-famous manufacturer of farm equipment.

In addition to these important production bonuses, you'll also save on the minimum space and maintenance requirements of the Stevens Model C. It's the ideal cost-cutter on all production plating and processing of small and medium-size parts. Call your Stevens Representative today for complete information, or write direct to:

(1) Loading chute automatically directs weighed parts into Stevens oblique, lidless barrels.

(2) Plated parts are automatically dumped directly onto a conveyor belt which transfers them to storage containers. No manual handling of parts is required.

frederic b. STEVENS, inc.

DETROIT 16, MICHIGAN

Buffalo • Chicago • Detroit • Cleveland • Dayton • Wallingford (Conn.) • Indianapolis • Springfield (Ohio)

Automated pre-plate* processing YOU CAN USE

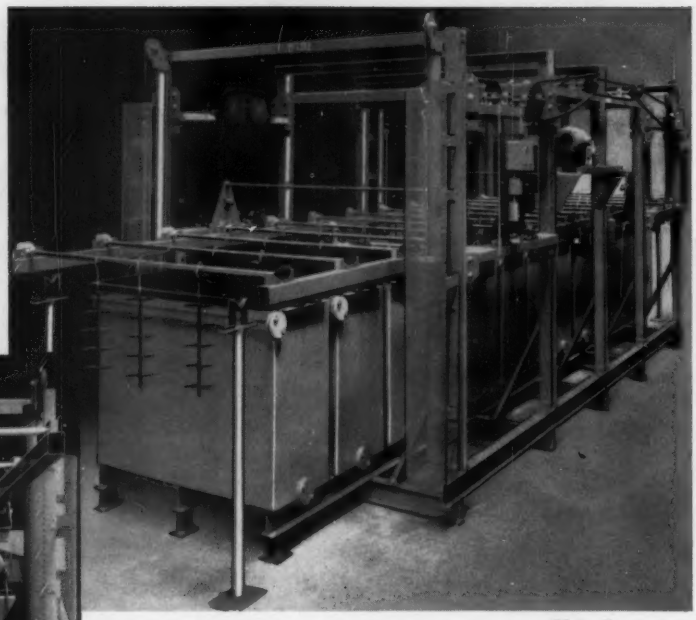


Fig. 1

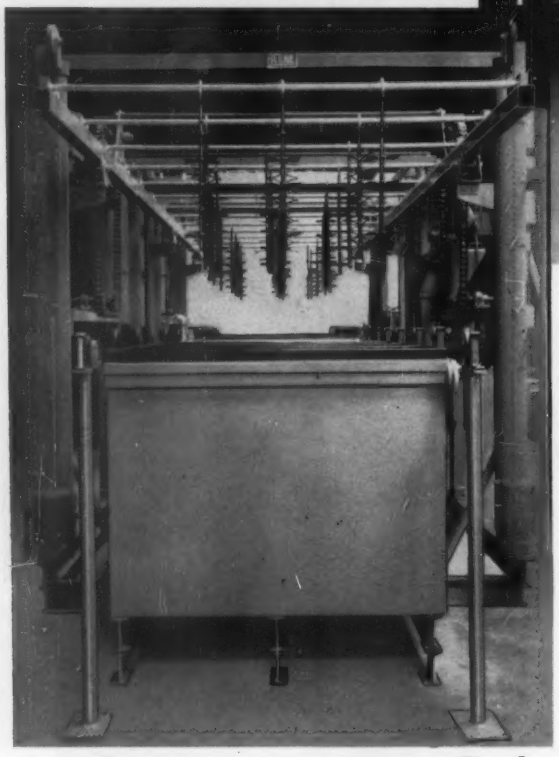


Fig. 2

Fig. 1. View of Automatic Processing Machine from unloading end showing a rod loaded with plating racks about to be deposited in the unloading stand. The racks are put on the rods on loading stands at the other end of the processing machine. The machine picks them up from the stands and transfers them from tank to tank at precisely timed intervals. Figure 2 shows the machine with the racks in the elevated position during the transfering operation.

Typical pre-plate cycles with the Automatic Processing Unit

Removal of carbon smuts, oxide smuts, buffing and drawing compounds, grease and oil from: 1) steel, 2) malleable and grey iron castings, 3) brass, bronze and copper, 4) brass, bronze, copper and steel in the same cycle, 5) die castings, 6) electrolytic descaling of iron and steel, 7) preparing aluminum for anodizing, chromating, painting.

*BELKE Automatic Processing Units are also used for pre-painting and other treatments that require dipping, soaking, electrocleaning, etc. Send requirement details for recommendations.

- **Adaptable to wide range of work**
- **Ends back-breaking lifting and walking**
- **Automatic Timing regulates processing and spurs output.**

Tremendous labor savings are achieved through use of BELKE Automatic Pre-plate Processing Units — especially in plants handling varied plating work.

These machines automatically take racked work from loading stands—automatically time and transfer the work through any desired pre-plate cycle such as electric cleaning, anodic electroclean, all sorts of baths and rinses—deposit the processed racks of work on unloading stands.

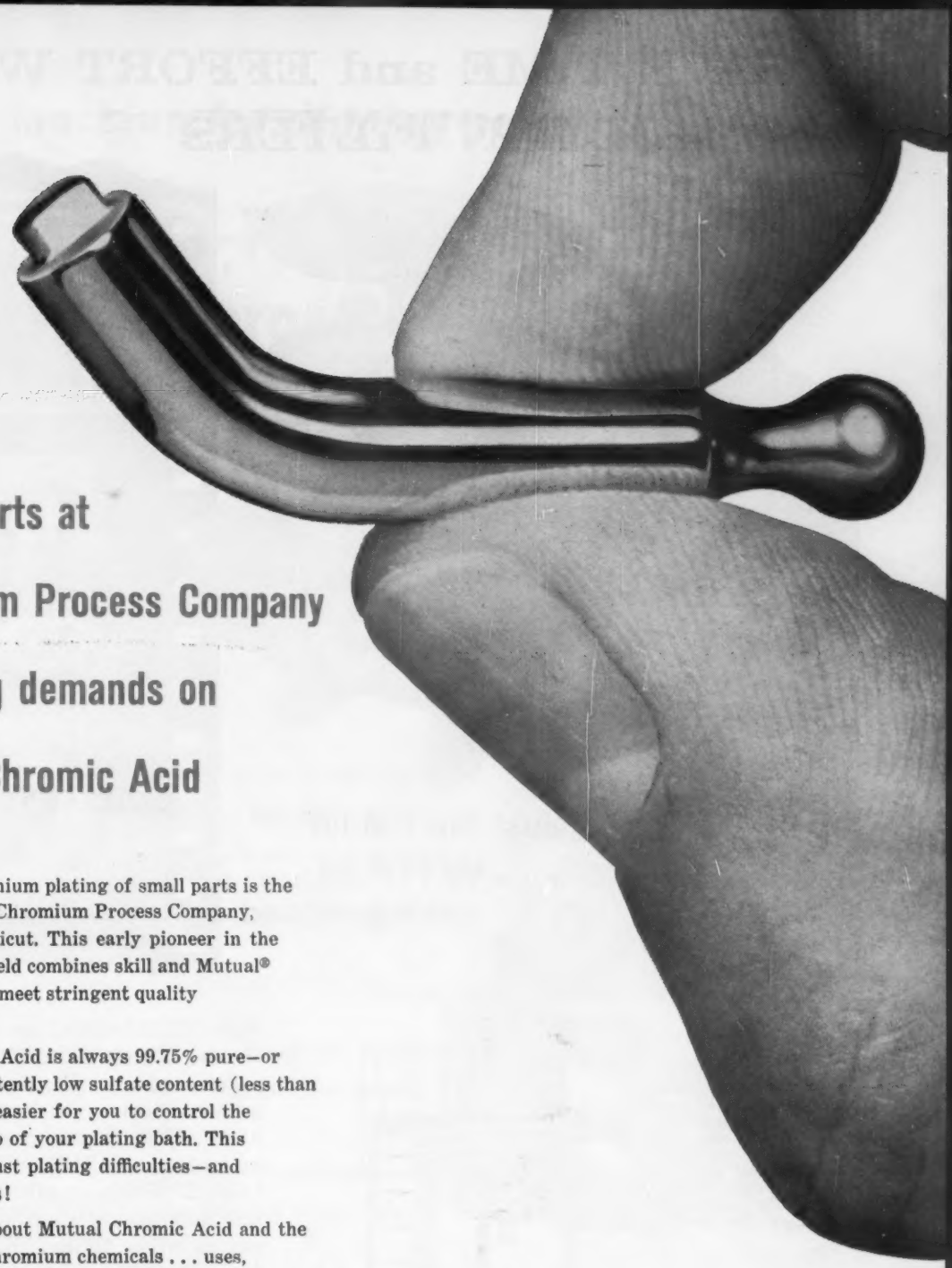
Different metals, ranging from die castings to steel can be processed with the same set-up by using adjustments for skipping tanks.

Widely varied shapes and sizes can be processed for plating in semi-automatics, automatic conveyor lines and in still tanks.

BELKE Automated Processing Units can be furnished in combination with completely automated systems or with combinations of automatic and manual plating facilities specially engineered for your requirements and conditions.

For suggestions, recommendations and quotations give us the details or send for a BELKE Service Engineer.

Belke MANUFACTURING COMPANY
947 N. Cicero Ave., Chicago 51, Ill.
EVERYTHING FOR PLATING PLANTS



Small parts at Chromium Process Company make big demands on Mutual Chromic Acid

Decorative chromium plating of small parts is the specialty of The Chromium Process Company, Shelton, Connecticut. This early pioneer in the custom plating field combines skill and Mutual® Chromic Acid to meet stringent quality requirements.

Mutual Chromic Acid is always 99.75% pure—or better. Its consistently low sulfate content (less than 0.1%) makes it easier for you to control the acid-sulfate ratio of your plating bath. This safeguards against plating difficulties—and expensive rejects!

To learn more about Mutual Chromic Acid and the Mutual line of chromium chemicals . . . uses, properties and comprehensive technical data . . . write for your free copy of Solvay's 80-page Technical Bulletin, "Chromium Chemicals." Our Technical Service Staff will also be happy to answer your questions. State whether you would like to have a representative call.

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Mutual Chromic Acid • Solvay Caustic Soda • Solvay Hydrogen Peroxide • Solvay Methylene Chloride • Mutual Sodium Chromate • Mutual Sodium Bichromate • Solvay Soda Ash

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Just flip the lid
. . . WHAM . . .
cake removed

CP-260

These rapid cleaning devices on INDUSTRIAL filters offer tremendous advantages to the user through removal of, and subsequent disposing of waste materials or recovery of valuable solids.

With VIBRA-SHOC or RECIPRO-SHOC, cleaning of your INDUSTRIAL filter is completed in minutes. The above mentioned trade named devices are obtainable on INDUSTRIAL'S TYPE 152 filters, as are such optional equipment as QUICK OPENING COVERS, LIQUID SHOC and AIR WASH, all designed with the efficiency you require for your particular operation. All these mechanical aids work for you to realize a definite cost savings based on reduced downtime, for either continuous or batch type operation. These self-cleaning devices also eliminate the manual dirty work in handling any dry, wet or semi-solid material.

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5906 **West Ogden Avenue, Chicago 50, Illinois**

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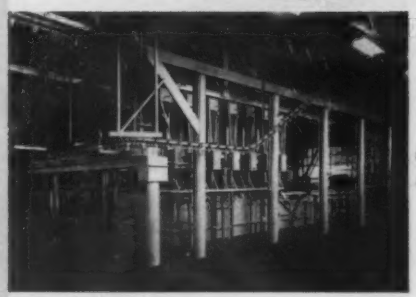
New machine for dipping processes...

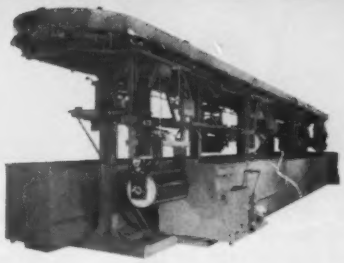
Crown "M-P" Multi-Purpose automatic processing conveyor

Crown M-P (Multi Purpose) Conveyors are a new development in basic design and control that brings automatic dipping processing to all industry for multi cycle processing in plating—anodizing—painting—phosphatizing and rubber dipping operations. Using the basic "M-P" concept, machines can be built to meet your specific requirements by incorporating one or several of these important Crown features:

- **Each carrier can be set for one of several different cycles.**
- **One machine that can plate two or three different metals.**
- **Horizontal and oblique barrels and even racks can operate on the same machine.**
- **Rack and barrel work can be plated at two different voltages on one machine.**
- **Work can be plated at four different thicknesses at the same time.**
- **Size of parts can vary from ¼ inch to 40 feet in length.**
- **Weight per station from ten to three thousand pounds.**
- **Lifts from 12 inches to 12 feet.**
- **Rotation, tilting, or other auxiliary motion during transfer.**
- **Machines of this type have been at work in actual production for over 2 years.**

Some typical "M-P" installations





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If your process includes a series of dips, you should know more about the Crown "M-P" . . . ask for our Bulletin M-P. Tell us your processing requirements and we will be glad to show you how the "M-P" can save you money.

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CLEANING	•	•	•	•	•	•	•	•		•			•
POLISHING	•	•	•	•	•	•	•	•		•			
PICKLING	•		•	•	•		•			•		•	
ELECTROPLATING	•	•	•	•	•	•	•	•		•	•	•	•
ELECTROPOLISHING	•						•						
NON-ELECTROLYTIC DEPOSITIONS	•	•											
ELECTROLYTIC OXIDATION	•						•						
ETCHING	•			•	•	•	•			•			
GOLD COLORING OF ALUMINUM							•	•	•				

CITRIC ACID... Non-toxic, mild, yet chemically active against scale and tarnish. Used extensively in the formulation of general metal cleaners and polishes, particularly household products.

SODIUM CITRATE... A preferred ingredient in electroless nickel baths, resulting in a brighter plate. Also finds wide use in electroplating processes.

AMMONIUM CITRATE... Especially useful for the removal of rust in near neutral solutions. Extremely mild and safe to handle.

GLUCONIC ACID... An excellent sequesterant in alkaline derusting solutions; provides rust-free, clean surface ready for further treatment. Also highly effective in aluminum etching and paint stripping compounds.

OXALIC ACID... The most effective chemical for use in automobile radiator cleaners. Also finds wide use in electropolishing and as an ingredient in general metal cleaners.

FERRIC AMMONIUM OXALATE... Used extensively in the production of light-fast gold-colored aluminum.

TARTARIC ACID... Excellent complexing agent for copper in electroplating.

TARTAR EMETIC... Used in electrolytic baths for deposition of silver and antimony alloys on brass, copper and steel surfaces.

ROCHELLE SALT... Increases efficiency and yields finer-grain deposit in alkaline copperplating.

CREAM OF TARTAR... An excellent additive for brass and aluminum cleaning compounds. Its crystalline structure acts as an effective abrasive in paste polishes. Chemically active against tarnish.

For further details write to Chas. Pfizer & Co., Inc., Chemical Division, Brooklyn 6, New York.

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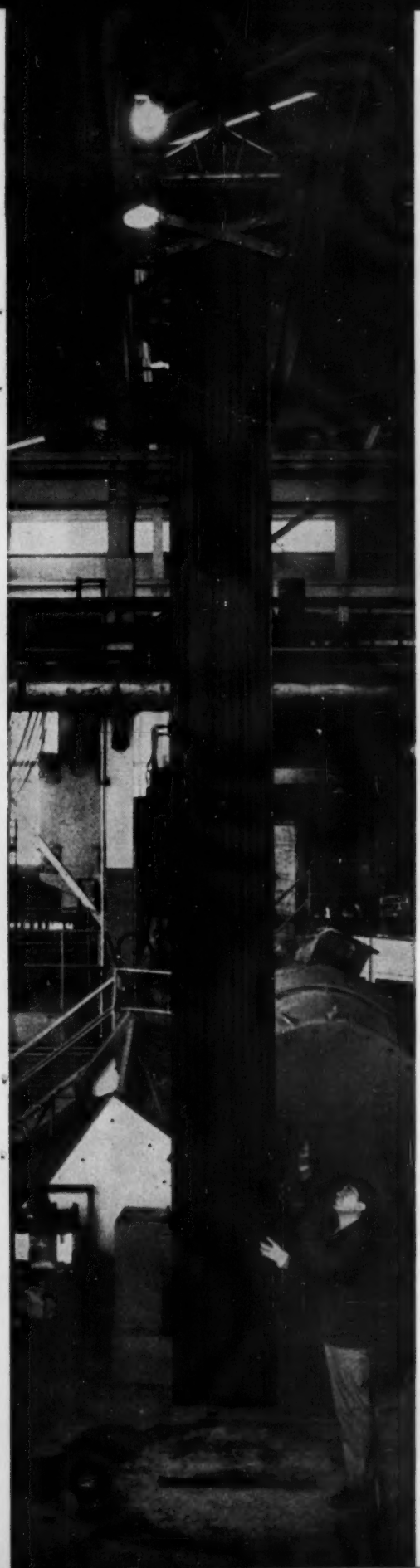
CHEMICAL DIVISION



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How close can you get to perfection in copper anodes?

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This firm was founded in 1876 by John L. Armitage's grandfather and sells on a nationwide basis to manufacturers of mainly metal products, some plastics and other non-metallics. Armorhide®, Armorsol®, and Armorette are its popular vinyl finishes.

Mr. Armitage has read METAL FINISHING since 1945 and advertised in it since 1957. He considers our technical articles to be the most authoritative in the field and believes they are geared to the interests of his type of customer.

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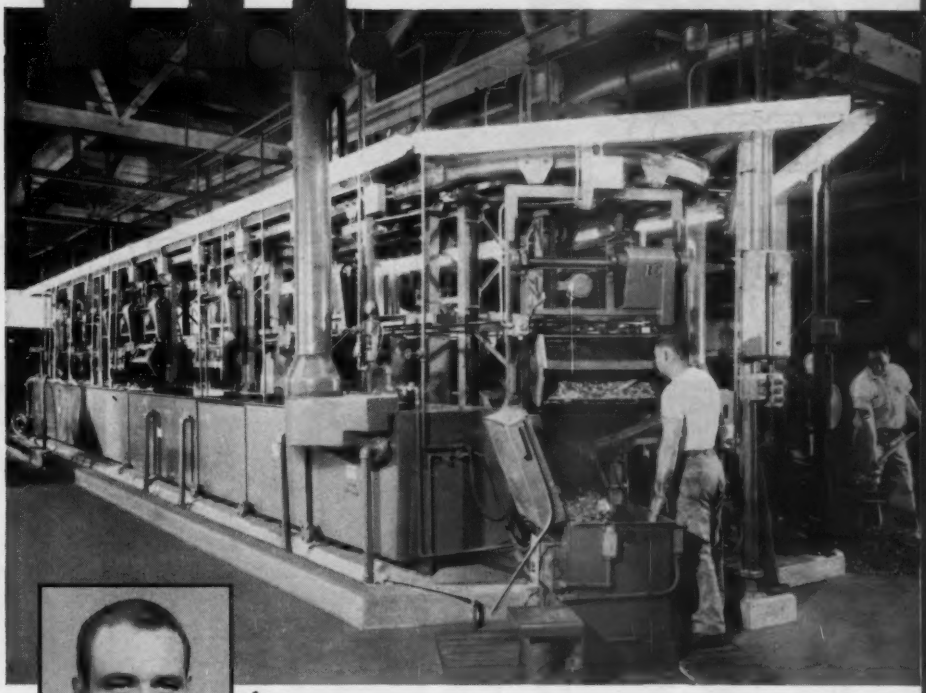


*Variable Integrated Processing steps-up production, improves plating efficiency for Chrome-Rite Company

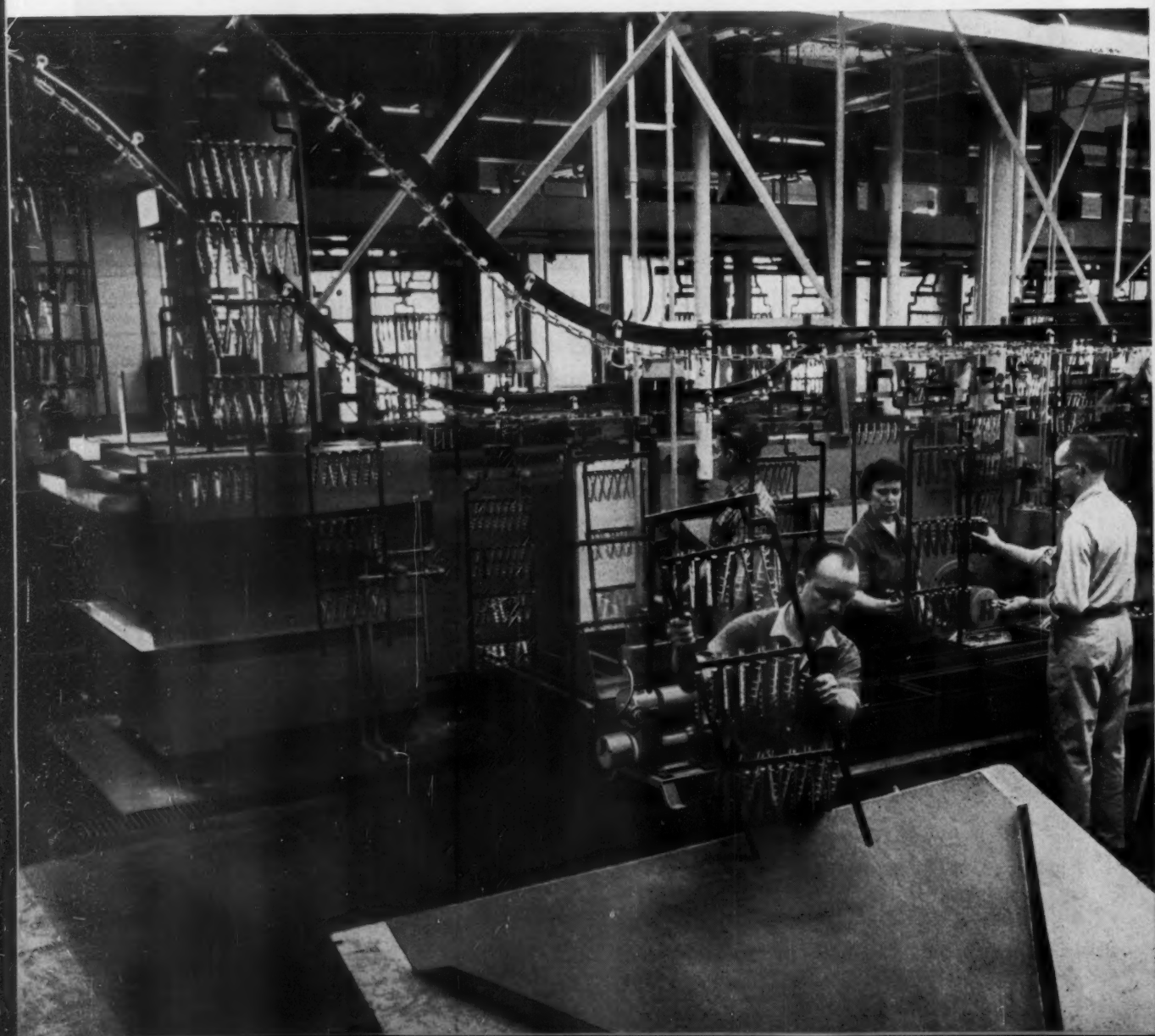
Chrome-Rite Company, Chicago, Illinois, a large job plating shop, recently selected and installed a Udylite V.I.P. Automatic Barrel Plating Machine to replace a manual line for zinc plating bulk parts.

"We find that our direct labor cost has been cut 60% while the cost of materials has decreased approximately 15%", writes Bill Crawford, Vice President. "In addition, we are now able to handle about 99% of our zinc plating volume on the new V.I.P. and maintain an even more consistent high finish-quality than ever before."

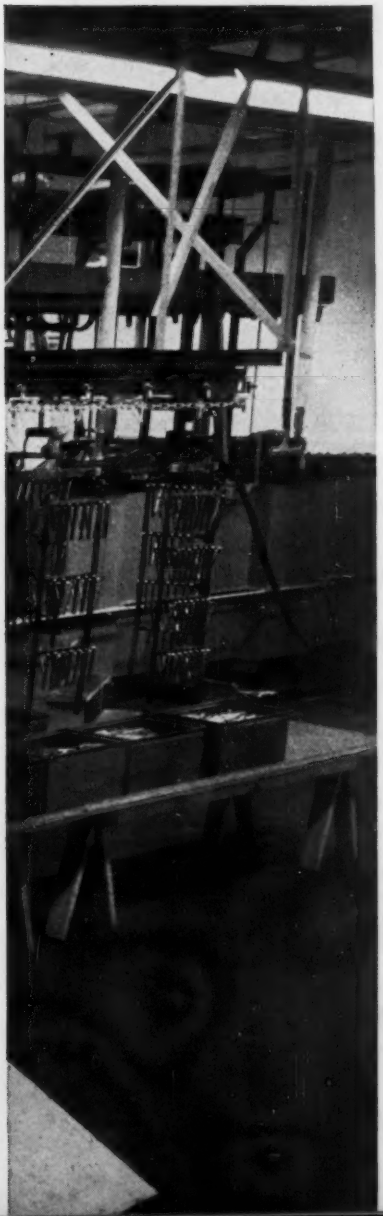
Experienced plating men like Bill Crawford are quick to note the many production plating advantages of the V.I.P. You, too, should consult your Udylite Sales Engineer for complete information on the versatile V.I.P. Call him today. Or, write:

Udylite corporation
detroit 11, michigan

here's plating automation



at its best!

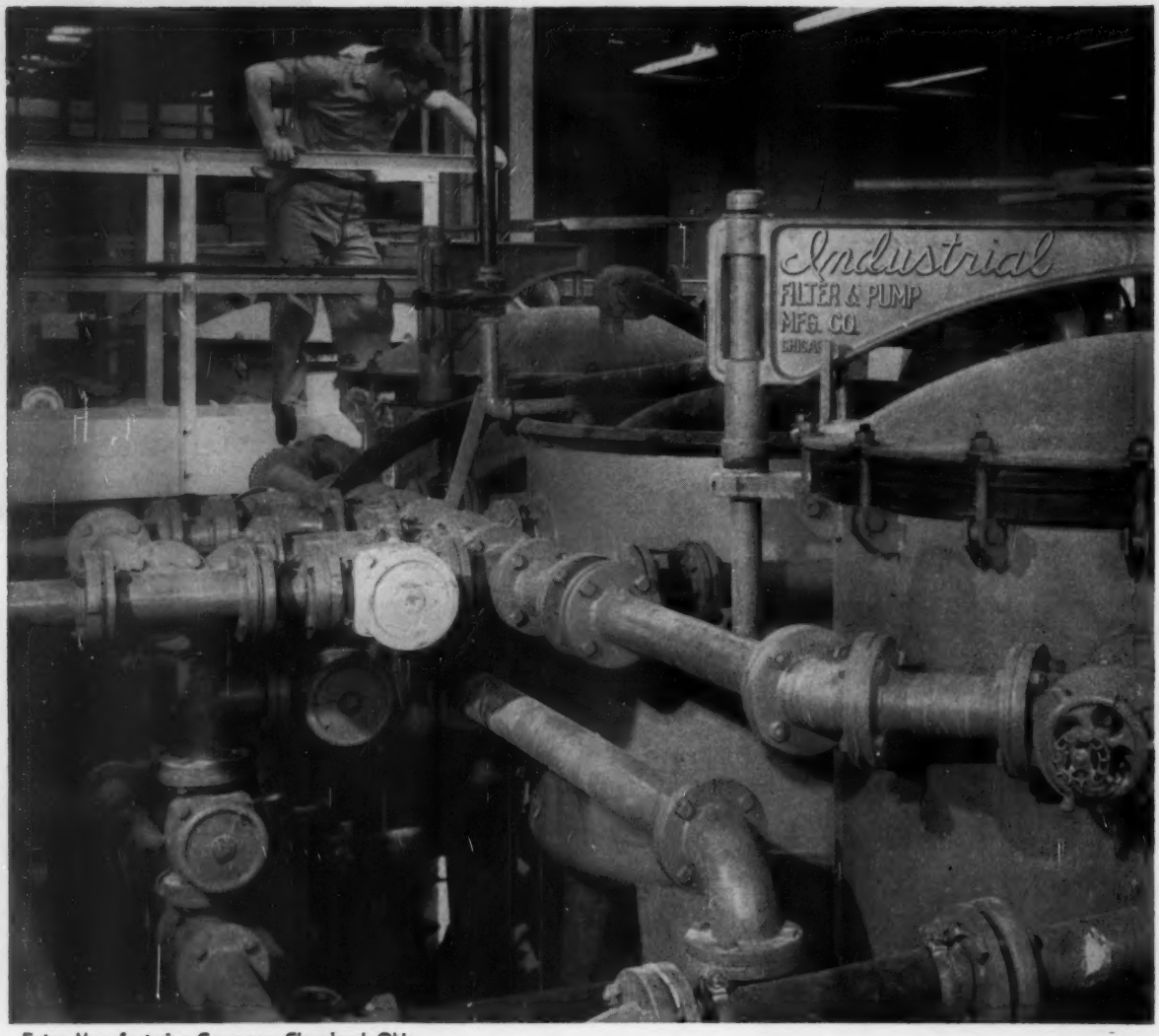


Udylite Cyclemaster ties into plant conveyor system, features automatic rack loading and unloading mechanism

A fully-automatic Udylite Cyclemaster was selected by Koelling Metal Parts, St. Louis, Missouri, to meet high-production, high-quality plating requirements on looseleaf binder and catalog components. This 15-station machine with automatic load and unload mechanism, shown above, is tied directly into a "stop and go" overhead plant conveyor system for maximum material flow efficiency. ■ This Udylite Cyclemaster provides peak production flexibility for Koelling. It operates at any rate from 40 to 120 racks per hour with plating thickness easily varied from .0001″ to .001″. Parts of any size can be plated within the limits of the 16″ x 8″ x 36″ racks. ■ The Cyclemaster maintains exacting quality control standards, boosts plating volume and offers an important reduction in floor space requirements. To find out how you can obtain the ultimate in automatic plating today at a surprisingly low cost, call your Udylite Representative and have him tell you the complete Cyclemaster story. Then, let Udylite Engineers recommend the specific machine and conveyor system to best meet your requirements.

Udylite

THE UDYLITE CORPORATION
DETROIT 11, MICHIGAN



Eaton Manufacturing Company, Cleveland, Ohio

"SARAN LINED PIPE

installs 3 times faster than other pipe we've used!"

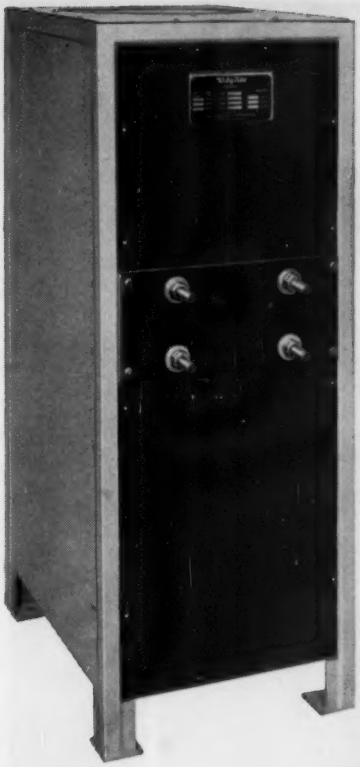
The Saran Lined Pipe above has carried more than 40,000,000 gallons of acid plating solutions at temperatures up to 160° F. In its 18 months of use, there's *not been a single failure* in the 1100 feet of Saran Lined Pipe at Eaton Manufacturing Company's Cleveland plant.

"In changing piping systems, our own maintenance men can put in Saran Lined Pipe with *no downtime* on our plating machines," says Mr. Harry Simpson, Maintenance Superintendent. "In fact, Saran Lined Pipe is so easy to cut and fit that we can't begin to estimate the total savings it's given us in time and labor, compared to other kinds of piping. We don't spend time waiting for a supplier to specially cut and rubber-line the pipe to fit our lines. We can put in Saran Lined Pipe three times faster than other piping—and indications are it will last substantially longer.

"In our experience, Saran Lined Pipe stands up extremely well under the hot muriatic and sulphuric acids we use and it has the strength and over-all economy we want."

For chemical processing plants, plating operations, and anywhere corrosive or reactive chemicals must be transferred, Saran Lined Pipe will give you one of the best and most durable piping systems obtainable. Saran Lined Pipe, fittings, valves and pumps are available for systems operating from vacuum to 300 psi, from below zero to 200° F. They can be cut, fitted and modified easily in the field with a minimum of special equipment. For more information, write Saran Lined Pipe Company, 2415 Burdette Avenue, Ferndale, Michigan, Dept. 1568CF8.

THE DOW CHEMICAL COMPANY DOW Midland, Michigan



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Rebuild your old equipment now!

Now's the right time to let Udylite electrical equipment specialists rebuild your old, inefficient, 6-, 9- and 12-volt UM and UV rectifiers. You can obtain all of the advantages of a completely new silicon unit at a cost just slightly more than a silicon diode replacement kit. With the exception of the transformer, you'll have *a brand new rectifier from top to bottom.*

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SILICON CONVERSION KITS—Udylite Silicon Diode Kits are also available for UV and UM rectifier conversion right in your plant. A specially fabricated heat sink assembly, complete with diodes and fuses, permits fast, easy installation.

Udylite

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Detroit 11, Michigan

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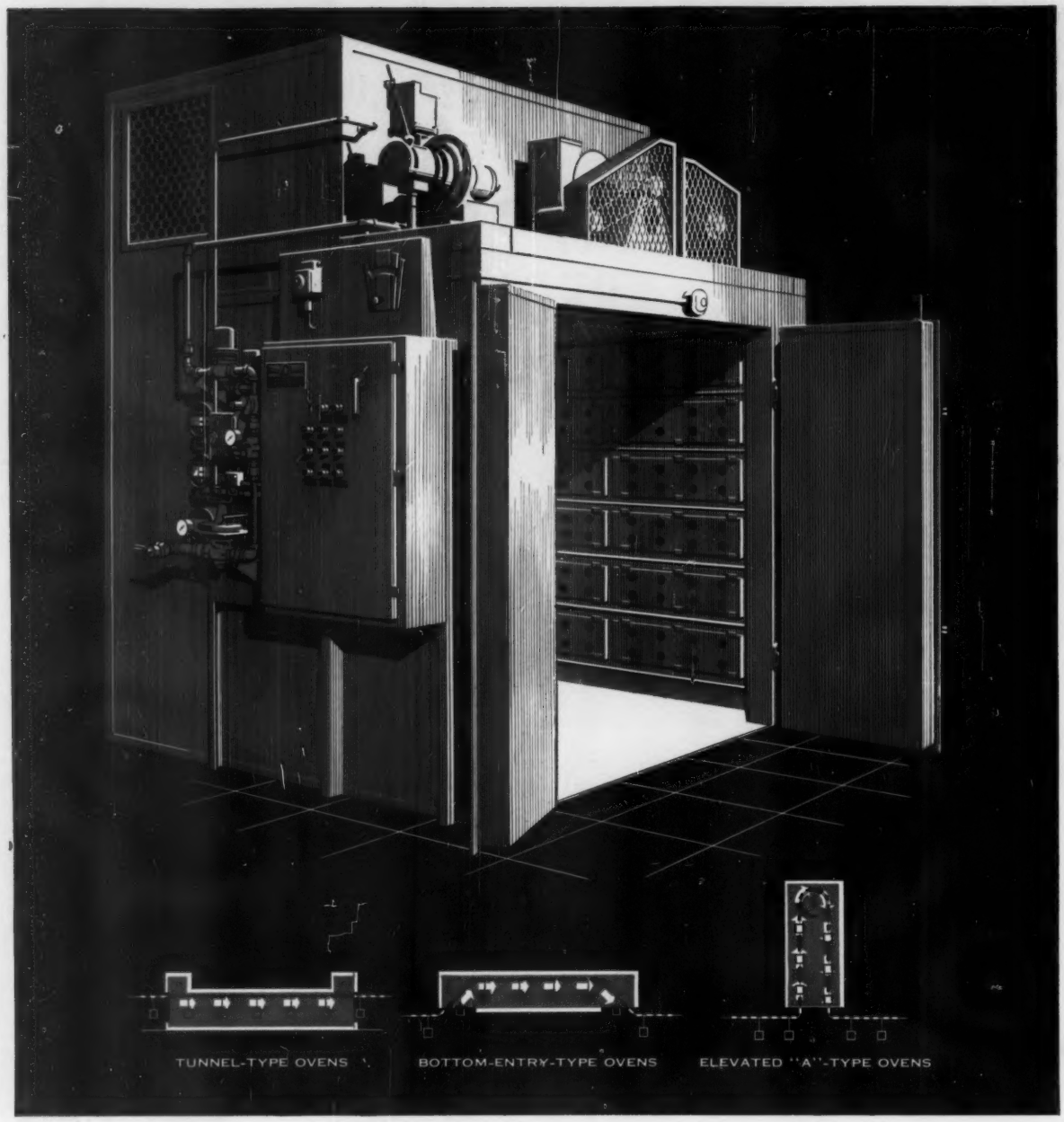

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20% more production on toughest job shop plating

...at no extra cost

Nothing tests a bath like a job shop—and A&A Plating Co. is one that often takes on "problem" jobs for other platers. Work ranges from marble size to big cash register shells, much of it tough combinations of zinc die casts and steel. And in 9 years of testing, A&A hasn't found a bright nickel bath that's "more profitable or easier to work with than Levelume 220." Some of the benefits that A&A reports:

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Buffing Eliminated on some jobs—at savings to $25 per 1000 parts. Same high-quality finish is achieved.

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Faster Plating. A&A has stepped up current and gets 20% more production at no increased cost.

What can *your* shop achieve with high-leveling, better-brightening Levelume 220? Contact H-VW-M for technical details.

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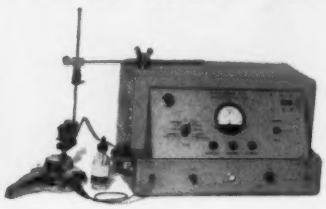

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Model 955 determines the thickness of heavy or decorative chromium, silver, tin, cadmium, zinc, brass, copper, nickel, lead and other alloy deposits, on various basis metals (including Copper-Nickel-Chromium composite coatings). Write for Bulletin 400 . . . and ask for a demonstration or 15 Day Free Trial!

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Now...single responsibility for bright finishing

M&T provides the complete plating "package" of chromium and all its undercoats

Now it's M&T all the way with a complete package of bright finishing processes and supplies. It's the same man who takes the trouble to keep trouble out of your copper-nickel-chromium finishing line.

More than this, the package brings you genuine operating advantages. Each process contributes uniquely to a quality bright finish.

Starting with M&T CYANIDE COPPER or UNICHROME® PYROPHOSPHATE COPPER you gain everything you could want from the undercoat: mirror deposits if desirable; wide bright plate range coupled with high speed; stable addition agents; economy. Simplest and shortest of control procedures, too.

With M&T BRIGHT NICKEL you get a stable, speedy solution that produces dazzling work. Deposits are smooth. Results are uniform. Upkeep is economical. (M&T now provides anodes made from Incobar* rolled nickel; and nickel salts, too.)

To top it off, UNICHROME SRHS® CHROMIUM COMPOUNDS make up baths that plate up to 80% faster; and with the easiest possible control: self-regulation. They plate M&T "MICRO-CRACK" CHROMIUM in a durable single deposit; or in a duplex deposit for better covering power in recesses and increased corrosion resistance.

Put M&T's long plating experience to work for you; let it help you cut bright finishing costs, reduce trouble and rejects. With just one call, get undivided technical help on all the processes...and a one-stop source for anodes, chemicals, brighteners, other addition agents.

M&T Plating Products

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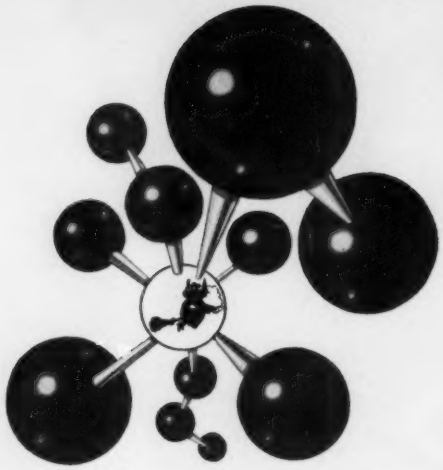

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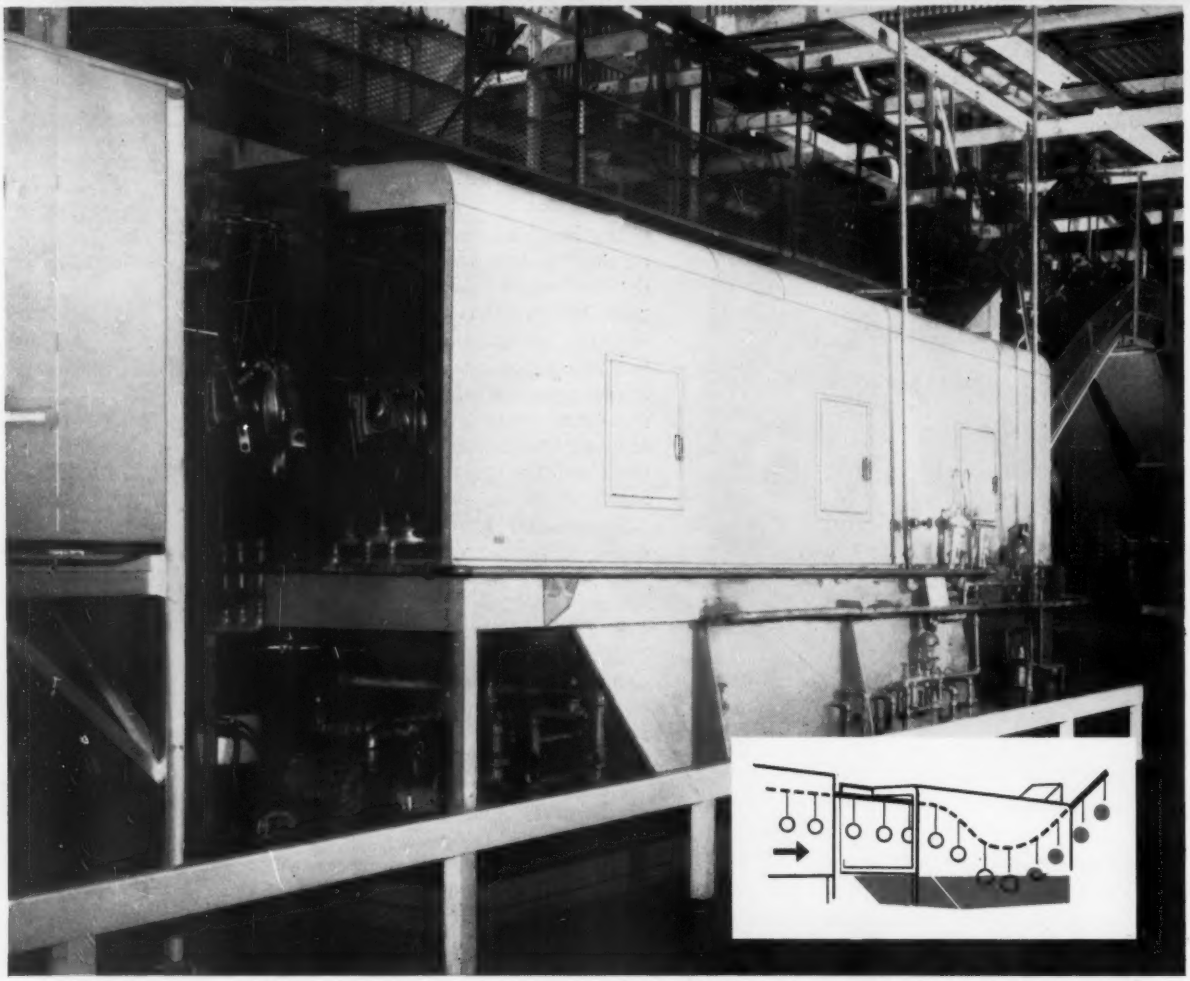

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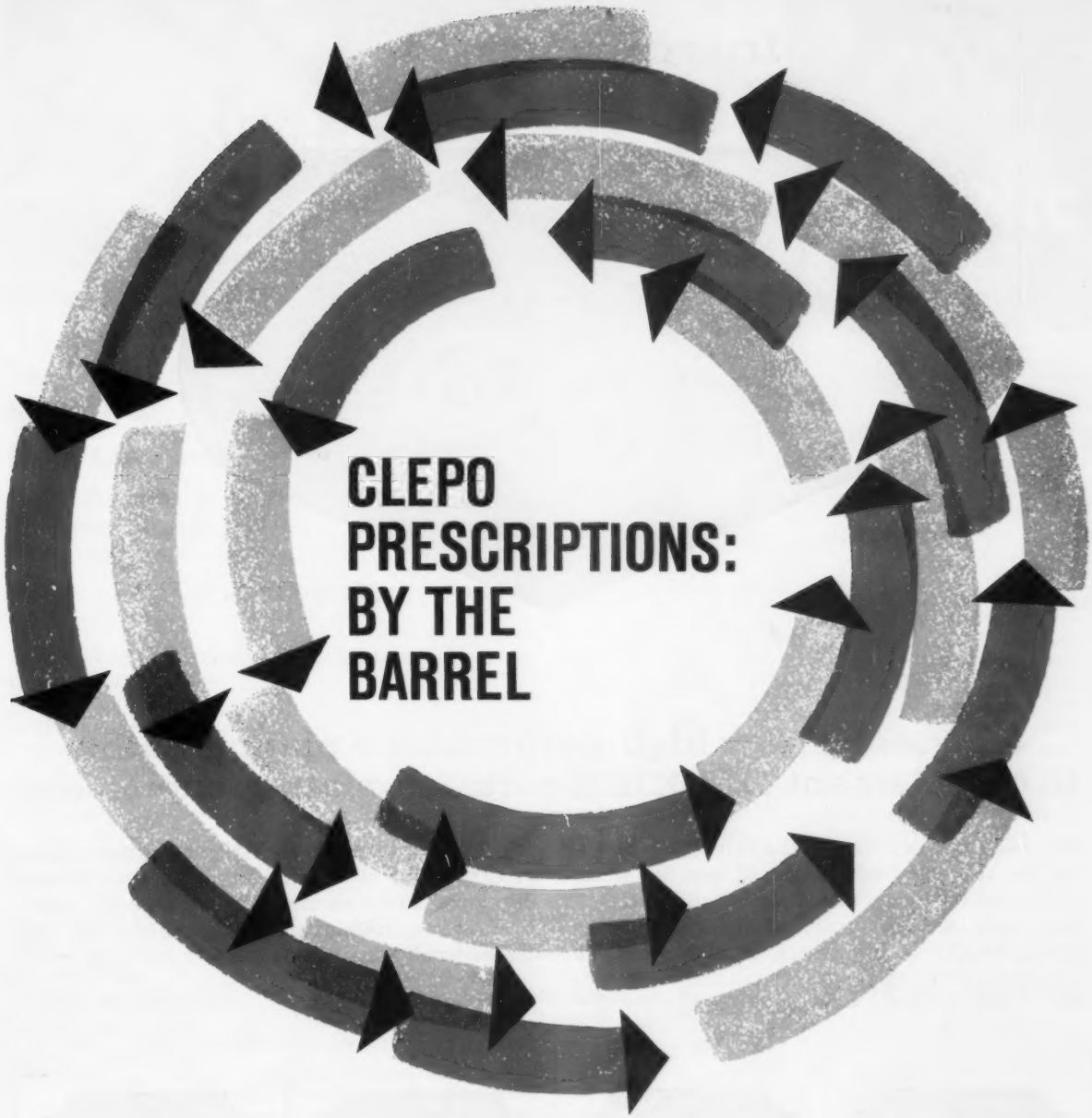

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AUGUST, 1961 Volume 59 No. 8

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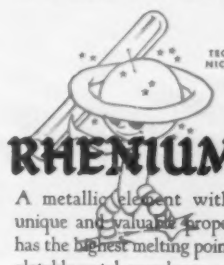

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ESTABLISHED 1903 VOLUME 59 • NUMBER 8 • AUGUST, 1961

BRING OUT THE SNAKE OIL!

The scientific regard for truth and exactitude, as opposed to the commercial predilection for half-truth and exaggeration, has been one of the few remaining bright spots in our industrial climate of recent years. An increasingly skeptical public has been bombarded with slogans, jingles, and such inane comparisons as relative quality, not of the tobacco, but of the cigarette paper. It was always expected, however, that articles in technical and scientific journals would be untainted, dedicated to the dissemination of information for the advancement of science, and for the benefit of practitioners in their particular fields. "Blessed is he who expects nothing, for he shall never be disappointed."

We are sure we have not been alone in noticing the increasingly regular appearance, on the lecture platform and in print, of the "pseudo-scientific" paper which, on later reflection, turns out to be only a series of claims for a proprietary product or process. METAL FINISHING considers such claims appropriate only in the section reserved for announcements of new developments and in the advertising pages, not in the feature section of the magazine. Articles rejected by us for this reason have subsequently appeared in other magazines with less exacting standards, which is their privilege, since it is they, not we, who are imposing on the reader. Of more serious consequence is the creeping perversion of the purpose of science and scientific publication which this tendency portends.

In some commercial circles it may be considered an accomplishment to get past an editor a puff or plug, under the guise of a scientific disclosure. Whether or not this redounds to the credit of the company or has any prestige value, or whether the reader feels taken-in, is not for us to say. This corner didn't feel particularly grateful when, a short while ago, he read a rather lengthy article, reinforced with theory, tables, diagrams, and photos, which purported to describe a new plating method. Boiled down, it claimed that, with an undisclosed procedure for preparing the basis metal, followed by plating under certain conditions which were sketchily detailed, a deposit could be obtained with certain advantageous characteristics, about which, at least, the authors were not at all reticent.

When a vendor exercises his right to keep details of his process secret, any performance data he submits are open to question, because the always-favorable findings cannot be confirmed independently. The reader can decide for himself how much credence to give such data and unverified claims when they are circulated as a bulletin by the vendor. However, published as a "technical" article, under the byline of eminent scientists, the doubts associated with awareness that a sales pitch is involved are extended, by inference, to other scientific authors. If our researchers are going to be turned into pitchmen, the result may very well be that, eventually, all published data will be suspect, even those emanating from unimpeachable sources.

Nathaniel Hall

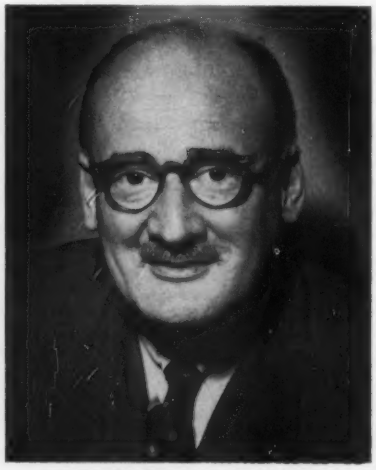
Boston A. E. S. Convention

Dr. Strauss delivering keynote address at opening session.

WHILE no attendance or other records were set, the 48th annual convention of the American Electroplaters' Society held in Boston, June 18-22 was the successful result of four years' planning and effort by the Boston Branch under the general chairmanship of *Louis V. Gagnon*, co-chairman *Dr. George P. Swift*, and their committees. Previous A.E.S. conventions held in the last two decades were in 1941 and 1950. The final registration count at this convention, which includes men, women and children, was 1,265.

Activities started Sunday as metal finishers arrived at the Statler Hilton from the United States, Canada, and a few from abroad. Several A.E.S. executive committees and the Metal Finishing Suppliers' Association trustees met on Sunday, and by evening there was a large group on hand for the Get-Together party. The official program got underway Monday morning with *Simon D. Strauss*, vice-president of the American Smelting and Refining Co., delivering the keynote address. His subject, "Competition Among the Primary Materials," was appropriately selected in view of the changes taking place in the electroplating and allied industries today. *Dr. W. Andrew Wesley*, president of the A.E.S. and associated with the International Nickel Co., presided at the opening session. Later in the day the third annual William Blum Lecture was given by *Dr. Charles L. Faust* of Battelle Memorial Institute. Dr. Faust was the 1960 winner of the A.E.S. Scientific Achievement Award which this year went to *Dr. Abner Brenner*, Chief of the Electrodeposition Section of the National Bureau of Standards, Washington, D. C. The re-

Chester G. Borlet, President AES



J. G. Carrique, President MFSA

Edward M. Marlette, President NAMF

E. E. Oberland
Third Vice President, AES

King Ruhly
Third Vice President, MFSA

port announcing Dr. Brenner's selection was made by *William M. Tucker* of the Eastman Kodak Co., chairman of the A.E.S. Selection Committee, itself composed of well-known scientists, namely *Dr. William Blum, Myron B. Diggin, Dr. Henry B. Linford, Dr. Louis Weisberg,* and *Dr. Harold J. Wiesner,* besides Mr. Tucker. Dr. Brenner was honored by the Institute of Metal Finishing (British) the previous month at its annual Conference where he received the Palladium Medal. Former winners of the A.E.S. Scientific Achievement award prior to Dr. Brenner and Dr. Faust were Dr. Blum and *Dr. A. Kenneth Graham* of Philadelphia. With the award is given an honorarium of $500.00.

Louis Gagnon, convention chairman, right, congratulating Dr. Abner Brenner, left, after announcing his selection as winner of the Scientific Achievement Award.

Other awards announced at the opening session were: the Carl E. Heussner gold medal for the best paper to *Dr. R. J. Barton* of the Wright-Patterson Air Force Base for his paper, "The Mechanism of Hydrogen Transport Across a Solution Metal Interface"; A.E.S. silver medal award for the second best paper to *Dr. D. E. Koontz, Dr. D. O. Feder* and *Dr. C. O. Thomas* of the Bell Telephone Laboratories; the A.E.S. bronze medal award to *Paul Glab* of Northwestern Plating Co., *S. P. Gary* and *R. S. Modjeska* of Scientific Control Laboratories; the George B. Hogaboom Memorial Nickel Plating award to *I. Tsu* of International Business Machines Corp.; the Robert S. Leather Mechanical Finishing award to *J. F. Poor, C. C. Alderuccio* of Allied Chemical Corp. and *H. Chessin* of the Van der Horst Corp.; the Precious Metal Plating award to *R. A. Ehrhardt* of Bell Telephone Laboratories; the Chromium Plating award to *W. H. Safranek* and *R. W. Hardy* of Battelle Memorial Institute; and the Aluminum award to *C. C. Cohn* and *M. Sosson* of the Colonial Alloys Co.

The educational program, which lasted through Thursday, was planned by *George J. Marotta* (Western Electric Co.) and Co-Chairman *Charles Levy* (Gillette Safety Razor Co.), with *Dr. Gerald H. Kissin* (Kaiser Aluminum and Chemical Corp.), a special member of the Boston Educational Committee responsible for the "Finishing of Light Metals" symposium.

A highlight of the closing business session was the presentation for the second time of the Charles H. Proctor Memorial Leadership Award named for the Society's founder to *Dr. Harold J. Read,* Professor of Metallurgy at Pennsylvania State University, who earned this honor for outstanding leadership and A.E.S. service performed as creator of the acclaimed "Hydrogen Embrittlement in Metal Finishing" symposium held by the Society at its convention in Los Angeles last year. *Walter Pinner* was the 1960 winner.

A record number of honorary memberships were conferred this year. Those honored included: *Myron Diggin* of the Hanson-Van Winkle-Munning Co., *William Neill* of Columbus Metal Products, Inc., *Daniel Gray,* formerly of Oneida Ltd. and now with Alpha Metals, Inc., *Raymond O'Connor* of Contract Plating Co., and *Manson Glover* of the Glover Coating Co.

Chester G. Borlet of Grand Rapids,

Dr. Simon D. Strauss
Keynote Speaker

Dr. Charles F. Faust
Delivered William Blum Lecture

Dr. R. J. Barton, left, receiving Heussner award from Glenn H. Friedt, Jr., with Dr. Wesley looking on.

Left to right, S. P. Gary, Paul Glab and R. S. Modjeska receiving the Bronze Medal Award.

R. A. Ehrhardt being given Precious Metal Plating Award.

The Chromium Plating Award went to W. H. Safranek.

C. C. Cohn receiving Aluminum Award.

Left to right: John Davidson, Ray Ledford, John Trumbour, Hank Kellner, Ed Marlette, Ezra Blount at MFSA luncheon.

Mich., an executive of the Grand Rapids Brass Co., was elected national president. A midwesterner and graduate of Kent State University with a B.S. degree in 1935, with further study at graduate level at Western Reserve University and the University of Detroit, Mr. Borlet has been technical director of the Grand Rapids firm since 1955. Prior to that he had been associated with the Harshaw Chemical Co., the New York-Ohio Chemical Co., and later manager of sales service at Harshaw. After his Harshaw affiliation, he became a district manager of the Metal and Thermit Corp., later occupying a similar post with McGean Chemical Co. Borlet is also a member of The Electrochemical Society and the A.S.T.M. B8 (Electrodeposition) Committee.

Other officers elected were: first vice-president, *Manuel Ben* with General Motors Corp.; second vice-president, *Frank O. Beuckman* with Eastman Kodak Co.; third vice-president, *E. E. Oberland* with the Western Electric Co.

The Metal Finishing Suppliers' Association 37th annual luncheon and business meeting was held in the Bay State Room of the Statler on Monday, June 19th. One hundred and twenty supply house representatives attended. *Fred Green* of Crown Rheostat and Supply Co. presided as president, and in his report as chief officer told the group of the aims of the organization and outlined the work done by its committees. *Rudy Hazucha* was honored as the only surviving member of the predecessor group, the International Fellowship Club founded in Montreal in 1924. The work of the M.F.S.A. in keeping the interval between finishing expositions to five years was reviewed, and it was pointed out that the last

Conventioneers at the Sunday Get-Together Party.

Left to right: Fred Green, Chet Borlet, Jeff Carrique, Bob Norton, Harold McCracken, Sherm Goble and Hugh McLeese at MFSA luncheon.

such exhibit was held in Detroit in 1959, and the next one is scheduled for St. Louis in 1964.

The advantages to suppliers of joint cocktail parties preceding A.E.S. social events were also reviewed. With regard to the future, President Green brought up the threat the industry is now facing by the substitution of other materials, reviewed how the M.F.S.A. has been studying the problem for the last three years, and what steps can be taken through a public relations program to combat these substitutes.

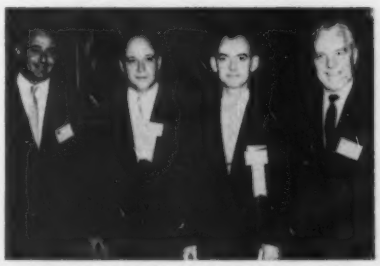
Secretary *Ezra Blount* reported that the M.F.S.A. had presented Thomas A. Trumbour awards to two new branches of the A.E.S. and also would present the award to the new San Diego branch in the near future. He also reported that the Information Bulletin published by the association for members and prospective members, which contains the work and aims of the association, had been distributed since the last annual luncheon. Another announcement made by the secretary was that approximately sixty-five members who had not received membership certificates would be receiving them in the very near future. A highlight of his report was the continued progress made by the association regarding joint cocktail parties at annual meetings of the branches of the A.E.S. Sixteen of these parties were held during the past year. The M.F.S.A. provided host badges at cost for use by the participating firms.

John E. Trumbour presented the treasurer's report.

Chet Borlet, president of the A.E.S., and *Ed Marlette*, president of the

John E. Trumbour, left, chatting with Moe Messing and his daughter, while Nat Hall and Palmer H. Langdon look on.

Andre Waldberg of Paris, France, chatting with Boris Joffe. At extreme right is Hugh McLeese.



Representatives of Raytheon Mfg. Co. at the Convention.

Ball team getting set for action at the clambake.

Another view of Sunday Get-Together Party.

Conventioneers ready and waiting at clambake.

Panelists who took part at the Finishing of Light Metals Symposium.

N.A.M.F., spoke as representatives of their respective groups and stated that their membership appreciated the cooperation extended to them by the M.F.S.A.

Charles Fotheringham, chairman of the resolutions committee, read the names of the deceased members since the last annual meeting.

Bob Burford and *Harry Sanders* of the golf committee announced that the 1961 tournament would be the last, as the trustees had voted that the tournaments be discontinued.

Under the big tent at clambake.

President Green then announced the results of the election of officers and trustees, which were as follows: President, *J. G. Carrique*, president of Alloycraft Ltd., Montreal, Canada, the first Canadian elected to this post in the history of the association; first vice-president, *Dr. H. L. Kellner*, Lea Mfg. Co.; second vice-president, *R. M. Norton*, Hanson-Van Winkle-Munning Co.; third vice-president, *K. Ruhly*, Michigan Chrome and Chemical Co.; treasurer, *J. E. Trumbour*, business manager of Metal Finishing; executive secretary, *E. A. Blount*, editor of Products Finishing; and trustees, *J. A. Cairns*, Allied Research Products, Inc.; *J. M. Davidson*, Pennsalt Chemicals Corp.; *R. C. Trees*, Udylite Corp.; *R. E. Belke*, Belke Mfg. Co.; *S. M. Goble*, Federated Metals Div., American Smelting and Refining Co.; and *H. D. McLeese*, Metal and Thermit Corp. The new officers were installed by *Rudy Hazucha* of the Clinton Co.

The National Association of Metal Finishers, whose national convention was held June 15-19 at the same hotel, elected *Edward N. Marlette*, general manager of Marlette Plating Co., Buffalo, N. Y., as president succeeding *Robert L. Giesel* of Adolph Plating, Inc. Marlette attended the Nichols School and graduated from Dartmouth in 1941. He is active in Buffalo civic affairs and is also a member of the A.E.S.

The other N.A.M.F. officers and directors are: first vice-president, *James E. Cogan, Jr.*, Globe Plating Co.; second vice-president, *Harold E. Coombes, Jr.*, Crown City Plating Co., secretary-treasurer, *Frank Kaiser*, Long Island Mechanical Plating Co.; assistant secretary-treasurer, *Sal Novelli*, Service Plating Co.; immediate past president, *Robert L. Giesel*, Adolph Plating, Inc. Directors: *E. Paul Koechritz*, L. A. Parkerizing; *John T. Hyduke*, Durable Plating Co.; *Glenn H. Friedt, Jr.*, United Platers, Inc.; *William R. Crawford*, Chrome-Rite Corp.; *J. William Carlson*, Arrow Plating Co.; *A. T. Leonard*, Superior Plating, Inc.; *Jules Horelick*, Allied Metal Finishing Co.; *Curtis M. Varland*, Varland Metal Service, Inc.; and *Napoleon A. Vigeant*, M & V Electroplating Co.

An interim A.E.S. business meeting will be held on January 13, 1962 in Indianapolis. Future conventions are: 1962, Milwaukee, Hotel Schroeder, June 24-28; 1963, Atlantic City, Ambassador Hotel; 1964, St. Louis (with exhibit); 1965, New York (hotel under construction); 1966, Atlanta Branch with convention in Miami Beach; 1967, Dallas.

John E. Trumbour, center, with Mr. and Mrs. Frank Kaiser of the NAMF. Frank received the Taormina Award presented by the NAMF.

Some of the photos used in this article were furnished us through the courtesy of the H-VW-M official Convention News published daily during the A.E.S. conventions since 1936 by the Hanson-Van Winkle-Munning Co.

New officers and trustees of the MFSA after being installed by Rudy Hazucha, only living founder of the International Fellowship Club, now the MFSA. Left to right: Rudy Hazucha, John M. Davidson, Al Cairns, John Trumbour, King Ruhly, Dr. H. L. Kellner, Jeff Carrique, Bob Norton, Sherm Goble and Ralph Belke. Ezra Blount, executive secretary, is seated in left foreground. Not present for photo: Fred Green, Bob Trees and Hugh McLeese.

Electrodeposition of Nickel-Iron Alloys From the Pyrophosphate Bath

By (Miss) Vasanta Sree and T. L. Rama Char, *Electrochemistry Laboratory, Department of Inorganic and Physical Chemistry, Indian Institute of Science, Bangalore, India*

Introduction

ALLOYS of nickel and iron have been deposited from sulphate,[1-3] chloride,[4] sulphate-chloride,[5,6] cyanide,[7] and citrate[8,9] solutions. It has been shown in this laboratory that the pyrophosphate bath is suitable for the deposition of nickel[10] and iron.[11] The preliminary work on the codeposition of nickel with iron from this bath has been briefly reported earlier.[12]

Experimental Procedure

The plating solutions were prepared from potassium pyrophosphate, nickel chloride and ferric chloride. The pyrophosphate concentration was in excess of that required for complex formation. The molar ratio of pyrophosphate $(P_2O_7)^{=-}$ to metal was 2.5. Only solutions containing a low nickel concentration of 0.025M and 0.05M, and iron concentration of 0.15M, required a ratio of 4 in order to keep them stable. Physico-chemical measurements have shown that the metal ion concentrations (g.ion/1) for the pyrophosphate complexes are of the order of 10^{-7} for iron and 10^{-5} for nickel. The nickel was estimated by the dimethylglyoxime method in the presence of citric acid, ferric iron by stannous chloride reduction and titration with standard potassium dichromate, pyrophosphate by the ammonium phosphomolybdate method, and orthophosphate by the method of Kolthoff and Stenger. The deposit was stripped from the cathode with a solution containing 50 ml. conc. nitric acid, 5 ml. conc. hydrochloric acid, and 45 ml. water. Nickel and iron were estimated as above.

Fresh solutions, 200 ml. of one concentration, were taken for each experiment — determination of current efficiency, deposit composition, and electrode potential at a given current density, with insoluble anodes. The same solution, however, was used for determinations at a number of current densities, for experiments with soluble anodes. A cylindrical hollow cathode of platinum or copper (1½" x ⅜" diam.) slipped over a stainless steel rod was placed inside a ring-shaped platinum anode such as used for electroanalysis, or an alloy anode (7/10" long x 1½" wide x ¼" thick). The inter-electrode distance was ½ inch. Cast anodes containing 40, 48 and 74 per cent nickel were used, the anode area being four times the cathode area. The bath was worked under still conditions, and the cathode efficiency was rather low under agitation. The plating time varied from 10 to 120 minutes.

The cathode efficiency was determined by the usual method for alloys.[13] A Philips conductivity bridge was used for specific resistance measurements. The pH

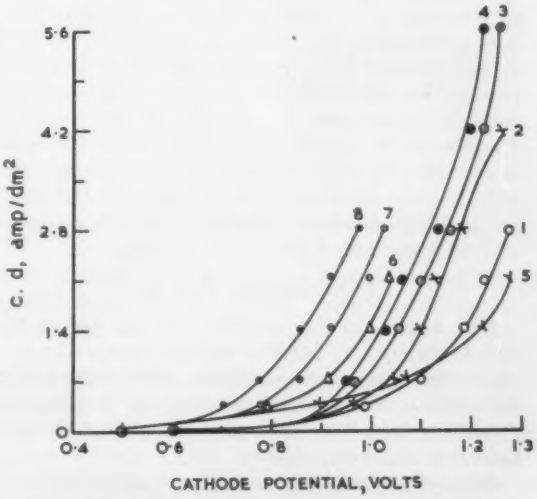


Fig. 1. Cathode Potential Curves for Nickel and Iron — Ratio 2.5, temp. 60°C. 1-4 Fe: (1) 0.025, (2) 0.05, (3) 0.1, (4) 0.15M; 5-8 Ni: (5) 0.05, (6) 0.1, (7) 0.2, (8) 0.3M.

TABLE I

Effect of Variables on Alloy Deposition

Variable	*% Ni in deposit*	*Cathode efficiency*	*Limiting c.d.*	*Cathode potential*
Fig. No.	2-4	5, 6	2-4	7, 8
Increase in c.d.	Decrease, then constant	General increase	—	Increase
Increase in Ni conc. of soln. —0.025, 0.05, 0.1, 0.2, 0.3M	Increase	Little change	Increase	Slight decrease
Increase in Fe conc. of soln. —0.025, 0.05, 0.1, 0.15M	Decrease	Variation irregular	Little change	Slight decrease
Increase in P_2O_7 conc. of soln. —ratio 2.1, 2.5, 3.0	Little change	Little change	Little change	Little change
Increase in total metal conc. of soln. —0.1, 0.2, 0.4, 0.53M	Little change	Variation irregular	Increase	Little change
Increase in pH of soln. 7.2, 8.3, 9.2	Slight decrease at lower c.d.	Increase	No change	Slight increase
Anode, Pt and 74% Ni	Little change	Little change	No change	Slight increase
Increase in temperature —40, 50, 60, 70, 80°C.	Increase	Slight increase up to 60°C.	Increase	Decrease
Agitation — 0, 800 r.p.m.	Little change	Decrease	Little change	Little change
Addition agents —				
rochelle salt, coumarin, saccharin	Decrease	Decrease	Slight decrease	Slight increase
sod. sulphite, ferrous ammon. sulphate	Little change	Little change	No change	Little change
boric acid	Increase	Decrease	Slight increase	Little change
ammon. citrate	Increase	Decrease at low and increase at high c.d.	Increase	Slight decrease

was measured with a glass electrode, and adjustments were made with hydrochloric acid or potassium hydroxide. Conditions were carefully controlled to obtain electrode potential values (hydrogen scale) to an accuracy of ± 0.005 v. However, the data have been presented to the second decimal place, the sign of the potential being negative for the cathode and positive for the anode. A decrease in the cathode potential means that the potential is less negative. The rest of the experimental details were the same as described before.[14] The conventional throwing number was calculated from the equation of Gardam[15] for a linear relationship between cathode potential and the logarithm of the current density.

Experimental Results

Fig. 1 presents the cathode potential curves for nickel and iron at different concentrations. The two curves are fairly close, and there is intersection in a few cases at lower current densities, showing thereby that alloy deposition is feasible. In general, iron is the baser of the two metals.

Alloy deposition was carried out under different conditions with respect to electrolyte concentration, addition agents, pH, and temperature. A detailed study was made of the effect of the variables on deposit composition, cathode efficiency, and cathode potential. There is no significant difference in the plating characteristics with insoluble and soluble anodes. However, alloy anodes containing 48 and 74 per cent nickel have also been used to study the effect of variation in the nickel and iron concentration of the solution. The 40 and 74 per cent nickel anodes have been employed for the control experiments. The results have been presented in Fig. 2 to 12, and Tables I to IV. To avoid overlapping, part of the data obtained are omitted from the figures and tables. The recorded data correspond to good quality deposits, and refer to insoluble anodes unless otherwise stated. The effect of the variables on alloy deposition is summarized in Table I.

The bath gives bright, adherent, and smooth alloy deposits with 4-87 per cent nickel, the color ranging from dull, light grey to bright white with an increase in the nickel content. The bath was stable under the experimental conditions. Beyond 80°C., however, the iron in the solution had a tendency to precipitate. The performance of the alloy anodes was fairly satisfactory, as substantiated by the control experiments summarized in Table II, and the anode potential curves of Fig. 10. The solutions could be used for several runs, and aging up to six months had little effect on

TABLE II

Control Experiments

Electrolyte: Ni 0.3M (17.64 g./l.), Fe 0.1M (5.58 g./l.), pH 8.2, sp. resistance 4.81 ohm.cm./cm.^{2}, vol. of electrolyte 200 ml., plating time 2 hours, c.d. — cathode 2.1 and anode 0.53 amp./dm.^{2}. Change in pH, sp. re-resistance and pyrophosphate — not appreciable.

Anode % Ni	*Potential, v.* Cathode	Anode	% Ni in deposit	*Efficiency %* Cathode	Anode	*Change in metal conc., g./l.* Ni	Fe
74	0.98	0.16	42	37	63	+ 0.5	+ 0.28
40	0.99	0.17	40	38	71	+ 0.2	+ 0.70

their performance. The orthophosphate in the solution was practically negligible. Coatings thicker than 0.0005" could be obtained. They were resistant to corrosion by the laboratory atmosphere (1 to 2 years) and did not change much in appearance or color. The total metal content was 99.9 to 100 per cent.

Table III gives the operating conditions for obtaining satisfactory deposits over a wide composition range, together with the plating characteristics under optimum conditions. The bath is fairly satisfactory for the plating of nickel-iron alloys. The cathode efficiency, however, is rather low.

Discussion

The experimental results show that the pyrophosphate bath is suitable for the plating of nickel-iron alloys. The total metal concentration in the nickel-iron pyrophosphate bath is comparable to that of acid and alkaline baths. The current density, however, is higher in the latter cases.

ALLOY COMPOSITION:

The nickel content of the deposit could be increased by an increase in the nickel or decrease in the iron concentration of the solution, decrease in current density and increase in the temperature, and to some extent by decrease in pH (Fig. 2-4). The other variables had no significant effect on the alloy composition, the maximum variation being 6 per cent nickel. The effect of current density was significant in the lower current density range; at higher current densities there was a tendency for constancy of composition. Similar observations have been made by Glasstone & Symes,[2] Stout & Carol,[7] and by Korovin.[8] A decrease in the nickel content of the deposit with agitation has

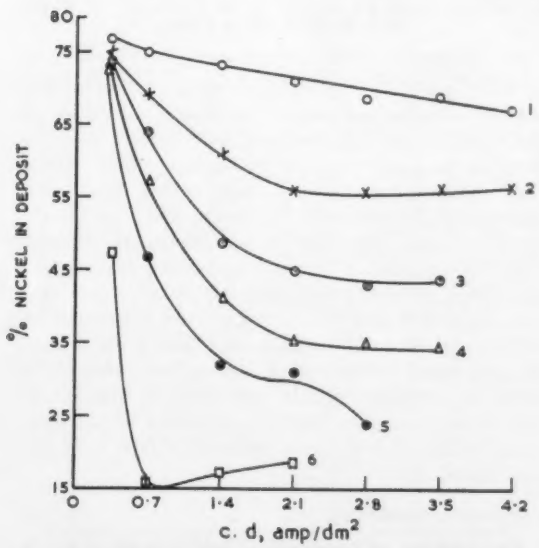


Fig. 2. Effect of Nickel and Iron Concentration in Solution on Deposit Composition — Electrolyte: (1) Ni 0.3, Fe 0.025, (2) Ni 0.3, Fe 0.05, (3) Ni 0.3, Fe 0.1, (4) Ni 0.3, Fe 0.15, (5) Ni 0.2, Fe 0.15, (6) Ni 0.1, Fe 0.15M.

TABLE III

Operating Conditions

	Range	*Optimum*
Bath composition, g./l.		
Nickel chloride ($NiCl_2 \cdot 6H_2O$)	6.0-71.4	71.4
Ferric chloride ($FeCl_3 \cdot 6H_2O$)	6.8-40.5	27.0
Pyrophosphate (P_2O_7)$^{--}$	43.5-231.4 (0.25-1.33M)	174.0 (1.0M)
Nickel	1.5-17.6 (0.025-0.3M)	17.6 (0.3M)
Iron	1.4-8.4 (0.025-0.15)	5.6 (0.1M)
pH	7.2-9.2	8.3
Temperature, °C.	40-80	60
Sp. resistance, ohm. cm./cm.^{2}	4.42-5.74	4.81
Bath voltage	0.9-2.6	0.9-1.6
Agitation, r.p.m.	0,800	—
Cathode	Pt, Cu	Pt, Cu
Anode, % Ni	40, 48, 74; Pt	74
Cathode c.d., amp./dm.^{2}	0.35-4.2	0.35-3.5
Anode c.d., amp./dm.^{2}	0.09-1.05	0.09-0.90
Cathode efficiency, %	6-54	32-41
Anode efficiency, %	63, 71	63
Cathode potential, v.	0.66-1.10	0.76-0.96
Anode potential, v.	0.01-0.23	0.01-0.23
Throwing number, N	—	0.1949
Deposit composition, % Ni	4-87	40-71
Time to deposit 0.0005 in., (min. at 2.1 amp./dm.^{2})	—	88

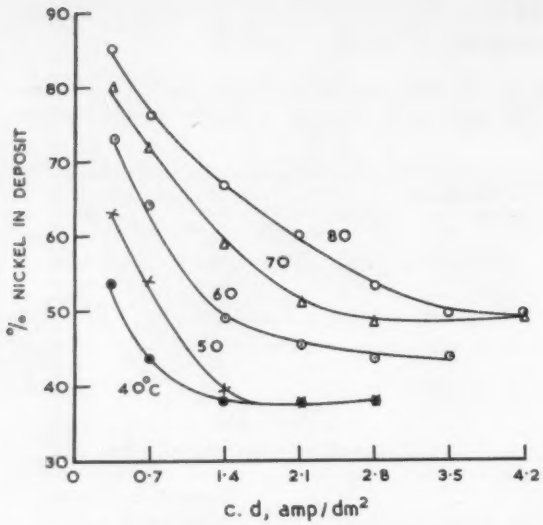


Fig. 3. Effect of Temperature on Deposit Composition — Ni 0.3M, Fe 0.1M, pH 8.3.

been reported by Glasstone & Symes.[2] An increase in the nickel content of the alloy with increase in temperature has been reported by Raub & Walter,[16] and by Sysoeva,[4] whereas Glasstone & Symes[2] and Stout & Carol[7] did not find any change. Work done in this laboratory has shown a similar constancy of composition during the deposition of alloys of nickel with cobalt,[17] tin[18] and zinc,[19] of tungsten with nickel,[20] cobalt[21] and iron,[22] and of iron with zinc[23] from pyrophosphate solutions.

In the deposition of nickel and iron, the free pyrophosphate concentration of the solution had little effect on the plating characteristics. The observed behavior in alloy deposition is to be attributed to the presence of the same complexing anion for both metals,

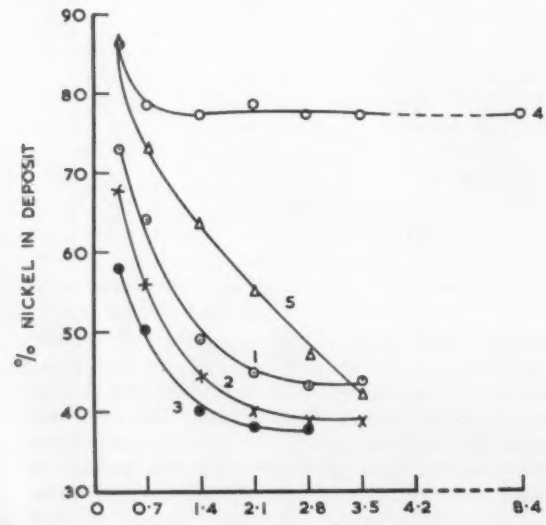


Fig. 4 — Effect of pH and Addition Agents on Deposit Composition — Ni 0.3M, Fe 0.1M, pH 8.3. Addition: (1) Nil, (2) sodium sulphite 0.5 g./l., (3) coumarin 0.5 g./l., (4) ammonium citrate 20 g./l.; (5) Nil, pH 7.2.

and the excess of free pyrophosphate in the bath. Some of the addition agents altered the deposit composition appreciably when added to the optimum concentration bath given in Table III. At a current density of 0.7 amp./dm.^{2} the nickel content in the deposit decreased from 64 to 48 per cent by 10 g./l. rochelle salt, to 50 per cent by 0.5 g./l. coumarin, and to 51 per cent by 1 g./l. saccharin. Addition of 20 g./l. ammonium citrate to the bath increased the nickel content from 45 to 81 per cent at 2.1 amp./dm.^{2}, and 10 g./l. boric acid increased the nickel content from 49 to 64 per cent at 1.4 amp./dm.^{2} Sodium sulphite and ferrous ammonium sulphate had little effect on the deposit composition. In cyanide solutions Stout & Carol[7] found that the addition of potassium chloride and an increase in the cyanide concentration of the solution gave only nickel in the deposit.

The ratio of the concentration of the two metals in pyrophosphate plating solutions is quite reasonable and also consistent with the ratio of the two metals

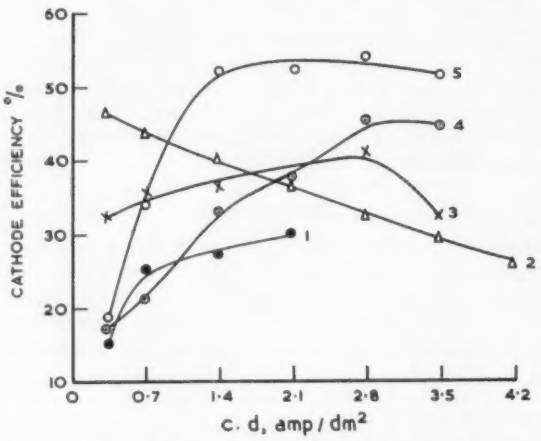


Fig. 5. Effect of Nickel and Iron Concentration in Solution on Cathode Efficiency — Alloy anode 74% Ni, electrolyte: (1) Ni 0.1, Fe 0.15, (2) Ni 0.3, Fe 0.05, (3) Ni 0.3, Fe 0.1, (4) Ni 0.3, Fe 0.15, (5) Ni 0.2, Fe 0.15M.

in the deposit. It is possible to obtain alloys of any desired composition without a drastic alteration of the metal ratios in the solution. Low current densities have to be used in order to deposit alloys with a high nickel content. Other workers, on the other hand, have stated that the ratio of iron to nickel in the deposit is higher than that in the electrolyte. Stout & Carol[7] report that a solution containing 10 per cent iron gives a deposit with not less than 60 per cent iron. Raub & Walter[16] state that the iron concentration of the sulphate bath should be less than 3 per cent of the total metal concentration. During electrodeposition from the sulphate-chloride bath Wolf & McConnell[5] have used a very low iron concentration of 1.2 g./l., nickel being 48.9 g./l., in order to obtain a 79 per cent nickel alloy.

CATHODE EFFICIENCY:

The cathode efficiencies with which pure nickel is deposited from a nickel pyrophosphate solution and iron from an iron pyrophosphate solution are, respectively, 36 to 88 and 7 to 66 per cent, if the baths are

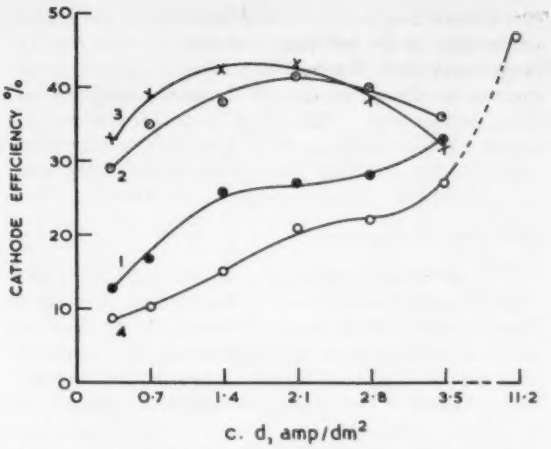


Fig. 6. Effect of pH and Ammonium citrate on Cathode Efficiency — Electrolyte: Ni 0.3M, Fe 0.1M. pH: (1) 7.2, (2) 8.3, (3) 9.2, (4) ammonium citrate 20 g./l., pH 8.3.

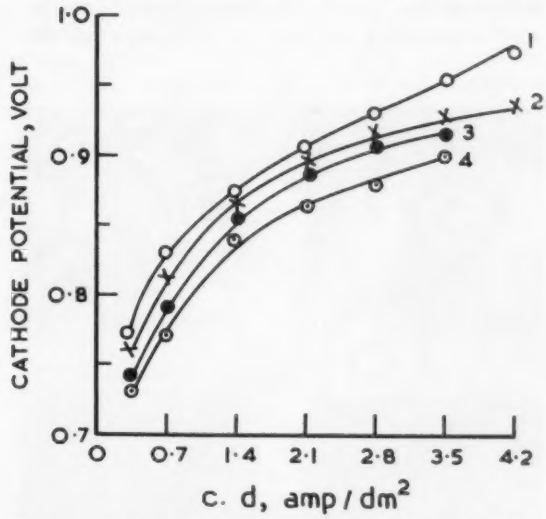


Fig. 7. Effect of Iron Concentration in Solution on Cathode Potential — Ni 0.3M, Fe: (1) 0.025M, (2) 0.05M, (3) 0.1M, (4) 0.15M.

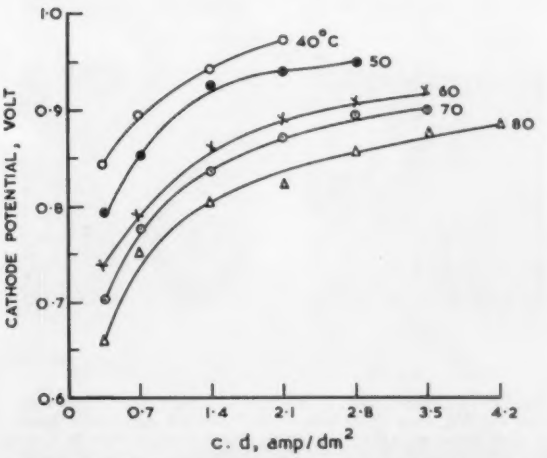


Fig. 8. Effect of Temperature on Cathode Potential — Conditions same as in Fig. 3.

operated over the same range of conditions as the alloy baths used in this study. The alloy efficiency is 6 to 54 per cent, generally closer to that of iron (Fig. 5 and 6). The cathode efficiency values reported by other workers are: Stout & Carol[7] 43-62, DuRose & Pine[24] 92-98, and Glasstone & Symes[2] 2-90 per cent; the latter have also observed that the efficiency increases with pH. The low alloy efficiency appears to be due chiefly to the low efficiency for the deposition of iron,[11] and also for the deposition of nickel from solutions not containing citrate.[10] An increase in the efficiency with increase in the pH of the solution can be attributed to an increase in the efficiency of nickel[10] as well as iron.[11] Ammonium citrate also increases the efficiency of alloy deposition at higher current densities. This is due to an increase in the nickel content of the alloy, as well as a higher efficiency for nickel deposition than for iron. Agitation decreases the alloy efficiency since it decreases the efficiency for nickel. The other variables had no marked effect, the maximum change being 12 per cent. Increase in the nickel concentration of the solution and temperature increased the limiting current density. Under optimum conditions the limiting current density values for nickel, iron, and the alloy are 2.8, 5.6, and 3.5 amp./dm.^{2} respectively. DuRose & Pine[24] have worked the sulphate bath up to 50 amp./dm.^{2}.

Cathode Potential:

The cathode potential during alloy deposition increased with increase in current density, decrease in temperature and agitation, decrease in the nickel or iron concentration of the solution and increase in the pH of the solution (Fig. 7 and 8). The other variables did not affect the potentials during alloy deposition beyond 0.08 v. The plating solutions possessed good throwing power, as observed visually. The deposition potentials for nickel, iron, and nickel-iron alloy in pyrophosphate solution under optimum conditions are 0.68, 0.66, and 0.50 v. respectively. From these values it is not possible to predict the alloy composition at low current densities. The relationship between cathode potential and logarithm of current density was linear (Fig. 9). Sysoeva[25] has obtained the Tafel plot during polarization studies for the deposition of this alloy from chloride solutions. In the high current density region, where the plate composition was practically constant, the potential changes were comparatively very small during deposition from the pyrophosphate bath.

From the alloy potential and composition it is possible to determine the proportion of the current that is used in the deposition of each metal and to plot corresponding potentials for each. Calculations of this nature, wherever possible, will give a fairly quantitative picture of the extent of influence of one metal over the other during alloy plating. Studies of this type have been made in this laboratory for the deposition of alloys of nickel with copper[26] and cobalt,[17] and zinc with copper,[14] nickel[19] and iron.[23] Fig. 11 presents the cathode potential curves of the nickel-iron system under optimum conditions: alloy potential, single metal potentials-observed and calculated. The reconstructed curves indicate that the po-

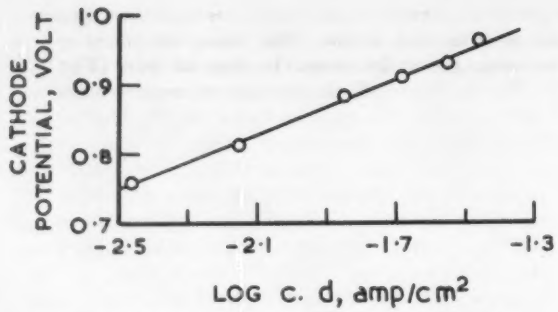


Fig. 9. Cathode Potential — Log c.d. line — Ni 0.3M, Fe 0.1M.

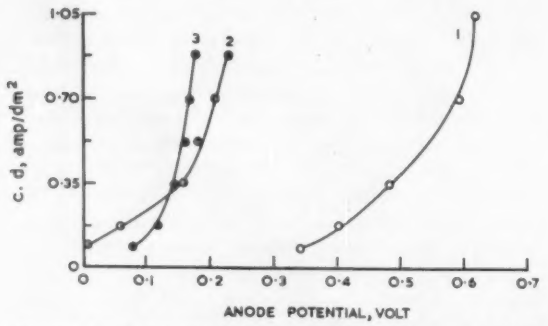


Fig. 10. Anode Potential Curves — Anode c.d. is given. (1) Ni anode in solution of Ni 0.3M, (2) 74% Ni anode in solution of Ni 0.3M, Fe 0.1M, (3) 48% Ni anode in solution of Ni 0.3M, Fe 0.1M.

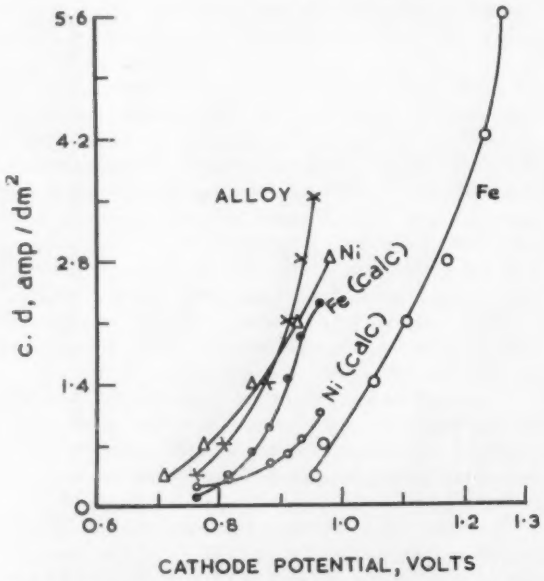


Fig. 11. Reconstruction of Single Metal Potential Curves from Alloy Composition and Potential — Bath Composition: Ni — 0.3, Fe — 0.1, Alloy — Ni 0.3, Fe 0.1M.

tentials of the two metals are close at very low current densities of the order of 0.35 amp./dm.^{2}. This can be attributed to a strong mutual influence of the two metals during codeposition, which results in an appreciable depolarization of iron deposition and an almost equal polarization of nickel deposition. Secondly, the experimental results show that, in most cases, there is a somewhat sudden drop in the nickel percentage of the alloy in the low current density range, 0.35 to 0.70 amp./dm.^{2}. The calculated curve for iron is closer to the alloy curve, showing that an alloy deposit with a high iron is to be obtained at higher current densities, as is actually the case. Calculations for solutions containing nickel 0.2M and iron 0.15M gave similar results.

STRUCTUE OF DEPOSITS:

The photomicrographs in Fig. 12 show that the electrodeposited alloy has a fine-grained structure. Plates 3 and 4 reveal spots, probably due to the evolution of hydrogen as a result of the low cathode efficiency, and plate 4 shows cracks in the deposit. X-ray studies of the deposit showed the existence of the gamma phase with f.c.c. structure, and the gamma plus alpha phase with f.c.c. and b.c.c. structures, as in the phase diagram (Table IV). For the f.c.c. structure there was an increase in the lattice constant value as the nickel content of the deposit decreased. Fedorova[27] has reported that the 31 per cent nickel alloy deposited from sulphate solutions containing

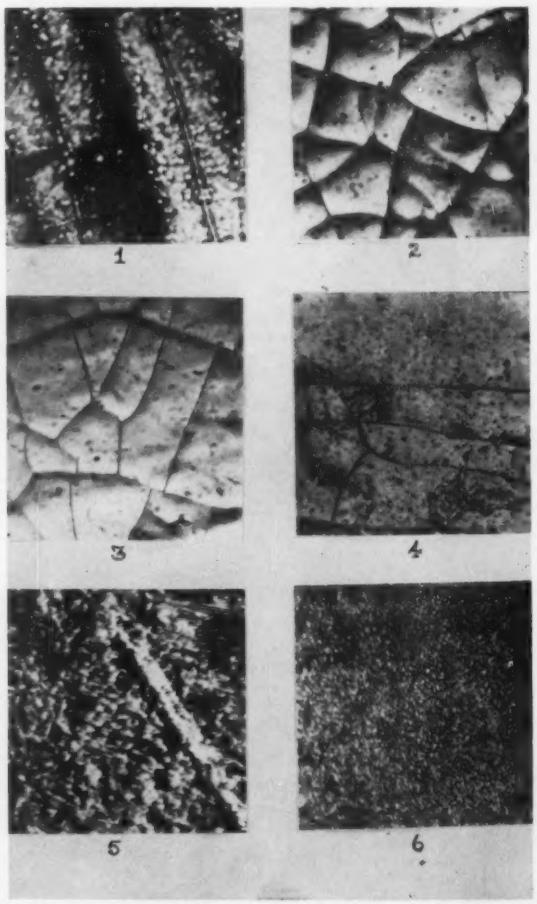


Fig. 12. Photomicrographs of Deposits — Copper base, magnification 1× 200. Plate 1, Ni only — Ni 0.3M, 2.1 amp./dm.^{2}; Plate 2, 75% Ni — Ni 0.3M, Fe 0.025M, 1.4 amp./dm.^{2}; Plate 3, 58% Ni — Ni 0.3M, Fe 0.05M, 2.1 amp./dm.^{2}; Plate 4, 42% Ni — Ni 0.3M, Fe 0.1M, 2.1 amp./dm.^{2}; Plate 5, 32% Ni — Ni 0.2M, Fe 0.15M, 2.1 amp./dm.^{2}; Plate 6, Fe only — Fe 0.1M, 2.1 amp./dm.^{2}.

TABLE IV

X-ray Studies

Conditions as in Fig. 12.

Plate No.	*% Ni*	*Phase*	*Lattice*	*Experimental a* Å	*Report a* Å
1	Nickel only		f.c.c.	3.501	3.517
2	75	γ	f.c.c.	3.530	3.518
3	58	γ	f.c.c.	3.536	3.544
4	42	γ	f.c.c.	3.579	3.581
5	32	$\gamma + \alpha$	f.c.c.	3.580	
			+b.c.c.	2.790	
6	Iron only		b.c.c.	2.857	2.861

citrate is a mixture of gamma and alpha phases; the alpha and gamma phases were also found. From the same solutions Marschak and Stepanow[28] as well as Fukuda[29] have identified only the alpha and gamma phases but not the mixture. Aotani[30] observed that nickel-iron alloys deposited from sulphate solutions had a magnified range of solid solutions containing 8 to 62 per cent nickel. The reported values in Table IV correspond to the nearest composition of the electrodeposited alloys cited by others.[28].

ANODE CORROSION:

The nickel anode corrodes satisfactorily in pyrophosphate solutions containing the chloride ion,[10] the anode efficiency being close to 100 per cent. On the other hand, the iron anode, either cast or electrolytic, was totally passive in solutions with or without chloride. However, anode corrosion was satisfactory with nickel-iron alloys of all the three compositions; they are solid solutions. The performance of the alloy anodes checked well with anode potential curves of Fig. 10 and analysis of the plating solutions (Table II). There is an increase in the metal concentration of the solution due to the difference in the electrode efficiencies. The bath requires careful control in industrial plating as there is a tendency for sludge formation. DuRose & Pine[24] have used alloy anodes, and there are several reports on plating with separate anodes of nickel and iron[3,4,31-33].

Acknowledgement

Our thanks are due to Prof. M. R. A. Rao for his keen interest in the work.

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Science for the Coatings Technologist

Part XVII. Dispersion Continued: Individual Mills.

By E. S. Beck.

This is the second half of Part XVII of this series. The first half appeared in the July issue.—Ed.

High Speed Impellers

This type of mill (Fig. 3) was originally introduced to the paint industry as a mixer or cutter for dissolving resins in solvents. It later was found useful for making pre-mixes for other mills. Most recently, it was shown that, by careful control of conditions, good grinds could be obtained in a great many instances. From this point, the use of the high-speed impeller as a grinding mill has expanded greatly. It is now an extremely popular mill for the production of many types of paints. The know-how for its use as a grinding mill has spread unusually fast; and one may predict that it will become the basic mill of the paint industry if its use continues to expand at the present rate.

This extremely rapid adoption of what is a very new milling technique speaks well of the advantages of the high speed impeller. And indeed, there are many advantages to the machine.

It is inexpensive, in relation to the cost of other types of mills. It is light in weight, and can be installed at almost any point in the paint factory where its use is indicated. Despite its relatively small size, it is not portable and all installations are fixed, although some can be tilt-mounted on tanks. It is very versatile, being useful for cutting resins or other solutions as well as making pre-mixes. It can be used for many grinds, as well, as will be considered below. It can be operated by relatively unskilled labor.

The machine is quite simple, reminding one of a large drill press in appearance. A long shaft with a specially-designed mixing disc, the impeller, is immersed in the material to be mixed, contained in a suitable tank. Models are made where the depth of the impeller is fixed; other models permit of variation in the depth of immersion by hydraulic action.

The heart of the machine is the impeller. This is a toothed or serrated disc which is set to spinning rapidly in the paint to produce the necessary agitation and shearing action. The design of the disc, the number and shape of the teeth or other structures on the disc which influence the turbulence, are all-important to obtaining good results. A number of manufacturers have taken out patents on the impeller design used in their mills.

The impellers are made in a selection of sizes, and best results are obtained when the proper size for the specific viscosity and batch size are used. This is only a detail: once established, the proper conditions can be specified for each succeeding batch.

The speed of the impeller is very rapid. Measurements are given in terms of peripheral speed, which will vary, of course, with the diameter of the impeller used. Speeds of about 2500 to 6000 feet per minute are obtainable. Some models have speed controls which are continuously variable; others have one or two fixed speed positions.

For cutting resins and making pre-mixes, speeds of 3000 to 4000 feet per minute are useful. For making good dispersions, Guggenheim[3] recommends a speed of 5000 peripheral feet per minute. The size of the

(Courtesy of The Cowles Co.)

Fig. 3. First of the high-speed impellers, with special toothed design of the impeller disc. The mixer is equipped with a hydraulic post for adjustment of height.

disc should be about one-third the diameter of the tank in which the paste is contained. Most manufacturers recommend these same ratios.

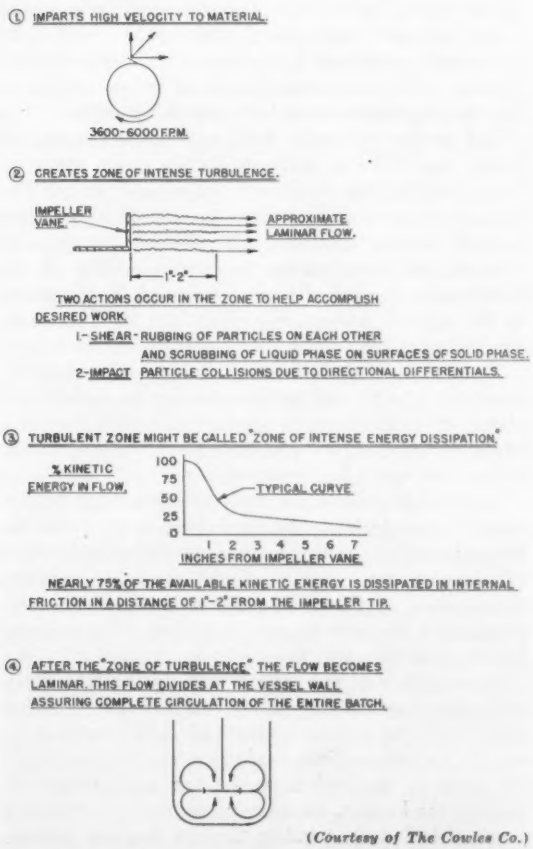
The importance of the speed and dimensions of the impeller lie in the fact that the rotating impeller is designed to do more than to simply mix the paint. When the proper conditions are met, the suspension is caused to move through itself very rapidly. In this way, an area of high energy is created, and the forces of impact and shear work on the suspended pigment particles. (See Fig. 4.)

Guggenheim points out a number of conditions which must be met in order to produce a good dispersion. The size and speed of the disc have already been mentioned. In addition, the practical lower limit of the paste level in the tank is about one-half the diameter of the impeller. The upper limit for the paste level is about two impeller diameters.

The consistency of the paste is also important. The paste must be sufficiently stiff to produce the necessary shear forces which break up the pigment aggregates. At the same time, the paste must be sufficiently thin to allow adequate flow into all parts of the tank.

Another factor is the depth to which the impeller is immersed into the paste. For best results, a depth of from one-third to one-half the liquid level from the bottom of the tank is used.

When the batch is being dispersed in the high-speed impeller, vehicle and pigment are added alternately,


① IMPARTS HIGH VELOCITY TO MATERIAL.
3600-6000 F.P.M.
② CREATES ZONE OF INTENSE TURBULENCE.
IMPELLER VANE.
APPROXIMATE LAMINAR FLOW.
1"-2"
TWO ACTIONS OCCUR IN THE ZONE TO HELP ACCOMPLISH DESIRED WORK.
1-SHEAR-RUBBING OF PARTICLES ON EACH OTHER AND SCRUBBING OF LIQUID PHASE ON SURFACES OF SOLID PHASE.
2-IMPACT PARTICLE COLLISIONS DUE TO DIRECTIONAL DIFFERENTIALS.
③ TURBULENT ZONE MIGHT BE CALLED "ZONE OF INTENSE ENERGY DISSIPATION."
% KINETIC ENERGY IN FLOW.
100
75
50
25
0
TYPICAL CURVE
1 2 3 4 5 6 7
INCHES FROM IMPELLER VANE.
NEARLY 75% OF THE AVAILABLE KINETIC ENERGY IS DISSIPATED IN INTERNAL FRICTION IN A DISTANCE OF 1"-2" FROM THE IMPELLER TIP.
④ AFTER THE "ZONE OF TURBULENCE" THE FLOW BECOMES LAMINAR. THIS FLOW DIVIDES AT THE VESSEL WALL ASSURING COMPLETE CIRCULATION OF THE ENTIRE BATCH.

(Courtesy of The Cowles Co.)

Fig. 4. Principles of operation of the high-speed impeller.

keeping a high viscosity. When all the pigment has been added, a "roll" should be formed. The paste forms what might be called a doughnut shape, with rapid motion away from the sides, and over and under the impeller. There should be no splashing, and about one-third of the area of the impeller should be visible. The paste should be pulled away from the sides of the tank cleanly and continuously. Once a few successful batches of paste have been made, the operator will have no difficulty in recognizing when the proper conditions are present.

Guggenheim advises that a round tank without baffles should be used. The impeller must be able to put the paste into a smooth, uniform motion, extending to the sides and bottom without interference.

Thickeners and puffing agents should be omitted from the mix to get the best in dispersion. They may be added subsequently. There is no over-all master formula which can be used in operating the high-speed impeller. For each pigment and each vehicle, there is an optimum pigment-to-vehicle ratio which will work the best. Actual batch testing is required to determine this ratio.

Guggenheim presents a formula by which this ratio may be roughly calculated in advance, but it is recommended (by this writer, not Mr. Guggenheim) that each mix be tried out experimentally before being put into production.

$$\text{The formula is: } F/c = 0.9 + \frac{V.S.}{145} + \frac{P}{40}$$

F/c is termed the oil absorption factor. It is a factor used to multiply the oil absorption requirement of the pigment in the batch. $V.S.$ is the percentage of vehicle solids in the binder; and P is the viscosity of the vehicle, expressed in poises.

To use this formula, the weight in pounds of the pigment it is desired to disperse is multiplied by the oil absorption of the pigment. (Oil absorption is a measure of the amount of oil required to form a liquid paste with the pigment in question.) This quantity is often called the oil demand of the pigment. The oil demand is then multiplied by the oil absorption factor. The result obtained is the number of pounds of vehicle to be used with the specified quantity of pigment.

The proportion of pigment used in pastes for the high-speed impeller is not as high as is used in the ball mill. A ratio of pigment to vehicle somewhere between that required for the roller mill and that performing best in the closed mills is suitable. The amount of pigment must not be too low, however, as both shear and impact will be lowered if the pigment content is allowed to fall too low.

When the dispersion has been prepared, the batch can often be let back and completed in the same tank. The high degree of intensive mixing needed for the dispersion is not required for reducing the paste into the final enamel formula. In most cases, there will be sufficient room in the tank for adding all of the ingredients. In those cases where the grind is to be held for later letting-back, it is good practice to add extra vehicle with good agitation, in order to obtain best stability.

After the grind has been prepared, care should be

taken to see that it is not contaminated with particles of unground pigment from the sides, the impeller shaft or the bung of the tank. These surfaces should be cleaned down with solvent after the composition of the paste has been completed in the mixer, and before the dispersing process has been long under way. If there is any danger of pigment clumping on the sides or bottom of the tank (because of too rapid addition of pigment during the early mixing stage) these areas should be well-scraped clean with a paddle.

By using these careful techniques, excellent grinds of soft pigments can be obtained on the high-speed impeller. Whites with grind gauge readings of 7 or 7½ can be obtained in quite short order. Guggenheim advises against the use of heat-reactive pigments. Coarse or hard pigments are not easily dispersed in this machine. In fact, it is not possible to reduce particle size (as can be done with ball mills or pebble mills).

However, coatings containing rough extender pigments which do not require a high degree of dispersion can be prepared on the high-speed impeller. An example would be exterior house paints, which often are formulated with fibrous magnesium silicate, which it is undesirable to break up too far. The machine is not well-suited for other materials containing hard extenders which must be dispersed to an extremely fine state, such as appliance primers and enamel undercoats.

Blacks and other difficult pigments are not too easy to disperse on the high-speed impeller. Where high gloss and maximum color development are not easily obtained, some other mill would be more suitable. Difficult binders, such as vinyls, are not suited for the impeller either. Most dispersions made on the high-speed impeller are in oils or alkyd resins or varnishes. All of these are good wetting, high-viscosity binders with ideal properties for use in the impeller.

In many cases, however, even where the high-speed impeller is not suitable for preparing the final grind, it is very useful as a pre-mixing mill. When an efficient pre-mixing operation is obtained, a large part of the dispersing process has been painlessly accomplished. The time on the final mill is accordingly reduced, allowing a greater productivity.

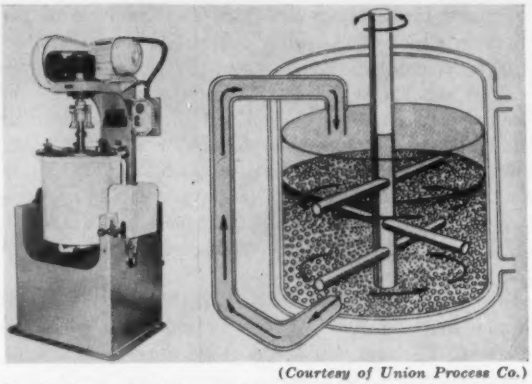
It is this great versatility, combined with the simplicity of operation of the impeller, which is contributing to its rapid adoption by so many paint manufacturers. Add to this its relatively low cost, low operating expenses, and high speed of output, and one has a mill with many very desirable features.

The Attritor

This mill (Fig. 5) is another of fairly recent development. It has a number of very desirable properties, and can be expected to increase in usage gradually as more manufacturers learn of it and evaluate it.

The attritor was developed by Dr. Szegvari, a research engineer with a machinery company. It was made to do one specific job better than anything available on the market at that time. That is, to prepare dispersions of usable quality in very short periods of time.

Two papers by Fenburr[4-5] show that it can do just



(Courtesy of Union Process Co.)

Fig. 5. Shown at left is one of the models of the attritor available for production; the figure on the right illustrates the internal working of the attritor.

that. Fenburr and his group worked with the pilot model, the second smallest sized attritor made (1 gal. tank capacity). They found that, working with a variety of pigments, good dispersions could be obtanied in from 10 to 30 minutes. Good dispersion was taken as a grind gauge reading of 7 minimum.

The machine itself is simple, relatively small, and while not literally portable, it can be transported from one location to another with a minimum of effort.

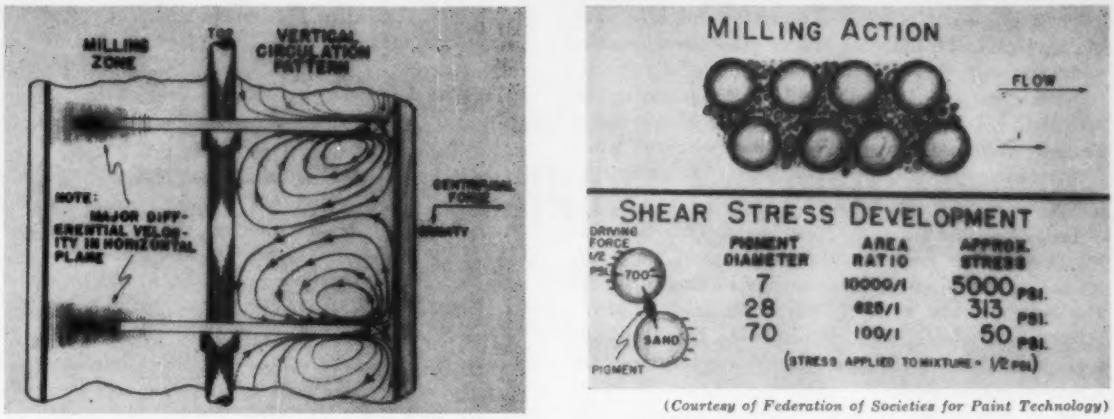
The manufacturer states that the power consumption is low since power is used solely to promote grinding. That is, there is no large drum to be rotated as in the case of the ball mill, which the attritor resembles in some other respects. The machine is too new for any power consumption studies to have been published, but study of its design would certainly indicate sharply reduced power consumption in comparison with ball and roller mills.

The attritor is made with a stationary tank, of rather small size as mills go in the paint industry. Extending into the tank is a rotor or agitator. The agitator has several projecting branches. The machine is filled during operation with enough flint pebbles to cover the branches on the rotor. Pebbles of approximately ½ inch diameter are used. The rotation of the agitator keeps the pebbles and the charge in continuous motion.

The agitator rotates at a slow speed, relatively speaking. In pilot models, the speed can be varied from about 160 to 200 rpm. In production models there are two fixed speeds: one at which the mill is operated, and a slow speed for emptying.

The mill is jacketed so that cold water can be circulated around the tank. Some heat is produced by the action of the mill. This has the undesirable effect of reducing the viscosity of the paste, so that the shear effects of the milling are reduced. If the temperature of the contents can be held at 70-80 degrees, fastest dispersion will be obtained.

A pump is also part of the mill. In the laboratory and pilot models, the pump removes the grinding paste from the bottom of the tank and returns it to the top. In intermediate production models, the grinding paste is removed from the top and pumped in through the bottom. Here the paste travels up through a cylindrical tank, passing through the full column of grinding medium on its way out through the top.



(Courtesy of Federation of Societies for Paint Technology)

Fig. 6. The sand grinder: left, patterns of vertical circulation and milling zones within the grinder; right, diagram of milling action and the development of shear between the pigment particles and the sand.

This design would seem the more effective.

The surfaces in contact with the paste to be ground are ceramic, flint, stainless steel, and other such materials. There is no danger of iron contamination of the batch. Copper is also excluded. This means that, unlike the steel ball mill, the attritor may be used for grinding whites, yellows, reds, and other clean, light colors.

Fenburr[4] found that the best grinding compositions were those based on use of the Dankel Flow-Point Method. That is a point of close correspondence with the operation of the ball mill. It will be recalled from an earlier article in this series that this method is based upon using high pigment loadings in a low-solids vehicle, to obtain maximum shearing action. In the case of the attritor, strict adherence to the flow-point data is not desirable. In the case of white pigments, good results are obtained at the flow-point values. With blacks, only one-half as much pigment is used as called for by the flow-point method. Other pigments fall between these values, depending on the difficulty of dispersion and the surface area of the pigments.

One drawback in using such high pigment loadings is the rather unstable dispersions which are produced. The dispersions which work the best in the attritor are so low in vehicle solids that they shock quite readily, in many instances, when they are let back with vehicle. The best way of handling this is to add the vehicle with the utmost care, a little at a time, with good agitation after each add. The attritor is then operated for a few minutes until the grind gauge reading returns to the value desired.

The attritor has the additional advantage that it can be operated without a premix operation. The vehicle is added to the mill first, and the pigment added, a portion at a time, with mixing between adds. The pump is not operated until the mass of the grinding paste becomes sufficiently fluid to be moved.

The attritor takes grinding pastes at rather high viscosities. Fenburr operated at viscosities of 50-150 K.U. His best results were obtained at the higher levels. For example, whites were ground at 143 K.U., yellows at 116 and blacks at 140. These are rather heavy viscosities, but they undoubtedly are reduced by the heat and mechanical action of the mill while operating.

The short amount of time required to obtain an excellent grind is the outstanding feature of the attritor. Some of Fenburr's dispersions were brought to a grind of 7 within 10 minutes. All of the pigments he investigated were dispersible within 35 minutes. The manufacturer claims that equal results can be obtained with all other pigments. If this proves to be true as more experience is gained with the mill, it will greatly increase the interest of paint manufacturers.

The Sand Grinder

This machine (Fig. 6) is quite new. The basic patent, issued to Seymour Hochberg, is dated January, 1952. The use of both the machine and know-how may be licensed at rather reasonable rates. The sand grinder is proving extremely popular; and its use is spreading through the paint industry at a rapid rate.

The machine has some points of similarity with the attritor which we have just discussed. It has at least as many points of difference, however. Both machines use a fixed drum within which an agitator rotates. The motion of the agitator moves both the charge and the grinding medium.

In the attritor, the paste to be ground is pumped over and over through the tank from bottom to top (or vice versa) until the desired degree of dispersion is obtained. When the grind is acceptable, the batch is dumped, and the next load added.

The sand grinder, in contrast, is often operated as a fully continuous-operating machine. The paste to be dispersed is passed through the grinding chamber and then out. The dispersion is produced and the paste is ready for reduction into finished paint. (Arrangements can be made for passing paste through the grinding chamber over and over. Frequently this is done. However, with properly-established conditions it should be unnecessary.)

The sand grinder requires a pre-mixing. The paste must be made in a sufficiently fluid condition that it will flow readily. The flow into the machine is by

gravity. The paste is taken through the machine and out by means of a pumping system. The newer models pump the paste through from the bottom of the grinding chamber out the top. While this pre-mixing is essential, it is not essential to obtain a high-quality partially-dispersed pre-mix paste. Experience with formulations will establish in each case the necessary quality of pre-mix needed.

The sand grinder uses 20-30 mesh Ottowa sand as the grinding medium. This is not only the best for the purpose by theory, according to Bosse[6] but is also best by actual test. This particular grade of sand is readily available, as it is also used for abrasion testing and is covered by an ASTM specification for a cement-testing sand.

The sand is quite low in cost, and lasts an extremely long time in service. In fact, sand is usually discarded while still usable. It is frequently simpler to discard sand when changing colors in preference to cleaning the sand by careful washing. Where dark colors have been ground, and white is to follow, it is common practice to discard the sand.

Where the same color is being continuously ground through the machine, it can be shown that the sand wear is very small. This is in marked contrast to other machines, such as the ball mill, where the balls wear down rather rapidly, and must be replaced on a regular basis. Bosse states that the initial release of fines in the sand is ended within the first hour of operation. Thirty days later, there is practically no sign of wear when the sand is examined microscopically.

The actual size of the grinding chamber is relatively small. Production models run from 18 to 30 gallons capacity, with 23 gallons representing a typical size. This apparently small size is matched, however, by a large output. A 23 or 30 gallon sand mill can keep two premixers going full blast, in tandem.

As with any other grinding device, conditions must be correct or unsatisfactory results will be obtained. The volume of sand to mill base is best held at one-to-one, computing the true solid sand volume (not apparent volume). If there is too much sand, the mixture of sand and grinding paste will become stiff, owing to dilatency. This will produce too much disc wear and give unsatisfactory grinding action.

Too little sand results in inadequate grinding action because of the wide spacing between the sand and the pigment particles.

The agitator consists of a double disc mounted on a rotating shaft. The disc must be made of hardened steel. It was found that discs made of steel with hardnesses below 40 Rockwell C wore excessively. Discs with hardness in excess of this figure had usable lives measured in years, according to Bosse.

There are a few types of pastes which produce excessive wear on discs even of proper hardness of steel. For these, glass discs were developed in laboratory models. These were good, but satisfactory production size glass discs could not be obtained readily. Nylon discs were then evaluated, and found satisfactory. These need be used only on a few difficult types of pastes. Clear flats, made with silica pigments are an example.

The milling takes place at the surface and edges of the discs. This zone, according to Bosse, apparently does not extend more than about an inch from the surface of the disc. This means that a quite small volume of the mill is actually involved in the grinding process. This small volume means that the power is applied with great efficiency. The circulation motion of the sand-paste mixture is in the form of circles, and a good circulation rate is needed to obtain proper grinding.

The motion of the sand is produced by hydraulic action. The viscosity of the grinding paste must be correct, or improper transfer of power will occur. If the viscosity is too low, there will be poor circulation and definite wearing of the disc.

The motion of the discs of the agitator also suspends the sand and circulates the mixture by a pumping action. Without this, good grinding is impossible. This motion is caused by the sand-grind mixture being made to rotate faster near the disc than further back in the grinding chamber.

It is this difference in speed of motion between layers of the sand-grinding paste mixture which produces the dispersing action of the sand grinder. While there are a number of different forces acting to some extent, shear is the principal pigment-dispersing force at work.

Like all other milling equipment, the sand grinder has its limits. There are some jobs it is able to do extremely well, others not so well. The sand grinder works best on pigments of small particle size, where the ratio of areas between the pigment particle and the sand particle are very large. In the case of pigments with a diameter of 7 microns, the ratio of areas is 10,000 to 1. Very large stress forces are produced, in the area of 5000 pounds per square inch. In consequence, on pigments with particle sizes in this range, the sand grinder has a powerful action, sufficient even to break crystals.

As the pigment particle size becomes larger, the dispersive forces in the sand grinder become less powerful. Agglomerates of 28 microns in size can be dispersed, even though they are strongly-bound, and imperfect crystals can still be broken. The stress force is approximately 300 pounds per square inch.

As the size of the agglomerate becomes still larger, the effectiveness of the mill is further reduced. At 70 microns agglomerate size, the mill can disperse only weakly- or moderately-bound agglomerates. And, on agglomerates of still larger size, the mill is almost without effect. At a particle size of 70 microns, the stress is only about 50 pounds per square inch.

All of the above data are from Bosse[6] as is most of the detail in this section. The reader who wants a fuller description of the properties of the sand grinder is urged to go to this excellent presentation for an almost complete discussion of the engineering properties of this mill.

While it would seem that coarse pigments demand

(*Continued on page* 64)

Finishing to Government Specifications

By Boris B. Joffe, *President, Twin City Testing Corp., Tonawanda, N. Y.*

The author wrote a previous article covering other specifications, which appeared in the May, 1961 issue. —Ed.

Black Chromium Plating (Electrodeposited)

Military Specification MIL-P-14583 (Ord.), dated June 14, 1957

I. Requirements

This specification covers an electrodeposited black chromium finish. It is hard, heat resistant, and corrosion resistant. It is generally applied to steel, but may be used on other metals.

The color of the finish shall be a dark gray, approaching black. If a color sample is provided by the procuring agency, it shall be matched for color. The finish shall be uniformly "dull" and without luster. No "bright" spots shall be allowed when examined under controlled light.

Unless otherwise specified, the plating shall be applied after all basis metal heat treatments and mechanical operations on the part to be plated have been completed.

All steel parts, having a hardness greater than Rockwell C 40, shall be stress-relieved prior to plating by heating for one hour at 300°-500°F.; this treatment shall not diminish the initial hardness.

If specified, plated parts shall be baked at 375° ± 25°F. for three hours after plating.

II. Sampling and Testing

For inspection purposes, the sampling procedure outlined in this specification shall be used.

Unless otherwise specified, the acceptance tests shall be carried out by the Government inspector.

The coating thickness and corrosion resistance test shall be made by the sulfuric acid drop test as outlined in this specification.

III. Notes

Black chromium deposits involve a dimensional change of approximately 0.0002 inch. As this increase is of little importance, no thickness requirement is given.

Black chromium may be deposited over bright chromium.

This specification describes equipment for the processing of parts to be black chromium plated.

A general formula is given:

Chromic acid	33-40 oz./gal.
Acetic acid (glacial)	28.2 "
Barium carbonate or Barium acetate	1 "

This specification also outlines solution maintenance procedures, as well as methods for analysis.

Black Nickel Plating (Electrodeposited)

Military Specification MIL-P-14535 (Ord.), dated June 12, 1957.

I. Requirements

The color of the finish shall be as specified by the procuring agency. The deposit shall be smooth and uniform and either lustrous and glossy black, or dull gray. If a color sample is provided by the procuring agency, it shall be matched for both color and luster.

Black nickel shall not be deposited directly on a ferrous base and, unless otherwise specified, shall be deposited over zinc, cadmium, or nickel.

The black nickel shall be deposited directly on a non-ferrous base such as zinc, brass, copper or nickel.

II. Sampling and Testing

For inspection purposes, the sampling procedure outlined in this specification shall be used.

Adhesion shall be tested by the bend test. No evidence of cracking and flaking shall be present when the test specimens are immersed for fifteen minutes in boiling water having a hardness of less than 30 grains.

The black nickel finish, furthermore, shall show no discoloration when submitted to the boiling water test.

III. Notes

Black nickel is primarily decorative in function.

Thin coatings are more adherent and ductile than heavy coats; heavy coatings tend to flake.

Black nickel deposits involve no dimensional change.

While called "black" nickel, the deposit is never dead black. The specified color, therefore, should be considered as a shade of gray and only an approximation of the color dip can be realized.

This specification also describes equipment for the

processing of parts to be black nickel plated.

The following black nickel solution formula is given for information purposes only:

Nickel sulfate	10-12 oz./gal.
Sodium thiocyanate	4-6 "
Zinc sulfate	4-6 "
Sodium or ammonium sulfate	2-4 "
pH	5.8-6.6, colorimetric
Current density	1-2 amp./ft.^{2}
Temperature	Room

Copper Plating (Electrodeposited)

Military Specification MIL-C-14550 (Ord.), dated June 30, 1957.

I. Classification

Copper plating shall be of the following classes:

Class 1: 0.0010 inch thick
Class 2: 0.0005 " "
Class 3: 0.0002 " "
Class 4: 0.0001 " "

II. Requirements

The basis metal shall be free from defects detrimental to the appearance or the protective value of the plating.

The plating shall be applied after all machining, welding, forming, impregnation and perforating operations on the article have been completed.

All steel parts, having a hardness greater than Rockwell C 40, shall be stress relieved prior to plating if they contain objectionable residual stresses.

Springs or other parts, having a hardness greater than Rockwell C 40 and subject to flexure or repeated impact shall be heated at 376° ± 25°F. for three hours after plating. Hardened parts, which have been heat treated previously at a temperature below 376°F., including carburized parts, shall not be heated as above.

The plated articles described above do not need to be baked if the procuring agency deems such a treatment to be unnecessary.

Spot-welded or articles which contain joints or recesses from which the plating solution may be difficult to rinse, shall be soaked for three minutes in clean hot water (200°-212°F.) subsequent to the plating operation.

III. Sampling and Testing

For inspection purposes, the sampling procedure outlined in this specification shall be used.

Adhesion shall be tested either by the bend test or by scraping the coating off the basis metal.

Unless otherwise specified, no thickness requirements are to be met on surfaces which cannot be touched by a sphere 0.75 inch in diameter.

Thickness measurements shall be made by approved magnetic instruments or by means of the metallographic microscope; the latter method shall be used as a referee test.

IV. Intended use

The copper plating classes are intended for such applications as the following:

Class 1: for carburizing shield or brazing operations
Class 2: as undercoating for nickel and other metals
Classes 3 & 4: to prevent basis metal migration into tin layer to poison solderability.

V. Note

This specification has been approved by the Department of the Army and is mandatory for use by the Army technical services.

Gold Plating (Electrodeposited)

Military Specification MIL-G-45204, dated March 7, 1960.

I. Classification

Gold plating provides a durable, tarnish-resistant finish intended primarily for engineering applications that require high electrical conductivity and permanently low electrical contact resistance. It shall be furnished in the following types:

Type I: 24 carat plate (99.5% gold min.): soft plate
Type II: 23+ carat plate (95.5% gold min.): hard plate

Type I plating is used for most industrial applications but, when abrasion and wear resistance are required, Type II plating should be specified.

Furthermore, gold plating shall be divided into six classes, based on the thickness of the deposit:

Class 1: 0.00005 in. min.
Class 2: 0.00010 "
Class 3: 0.00020 "
Class 4: 0.00030 "
Class 5: 0.00050 "
Class 6: 0.00150 "

II. Requirements

Bright gold plating shall be preferred; however, mat deposits are acceptable, unless otherwise specified.

The basis metal shall be free from defects detrimental to the appearance or the protective value of the coating.

Unless otherwise specified, the plating shall be applied after all basis metal heat treatments and mechanical operations on the part to be plated have been completed.

All steel parts, having a hardness greater than Rockwell C 40, shall be stress relieved prior to plating if they contain objectionable stresses.

If the gold plating is to be applied directly to the basis metal, without an undercoating, it shall be preceded by a copper, silver, or nickel strike.

For exterior use and when the basis metal is noncupreous, the total thickness of the strike and undercoating shall be 0.001 inch minimum, less the thickness of the gold plate itself.

Unless otherwise specified, parts having a hardness greater than Rockwell C 40 shall be baked at 375° ± 25°F. for three hours after plating. Hardened parts, which have been heat treated previously at a temperature below 375°F., including carburized parts, shall not be heated as above.

If selective plating is required, the coating shall

blend smoothly into the unplated surface.

The gold plating shall be free from defects detrimental to its intended use.

After plating, residual plating salts shall be removed from the articles. Several methods for this purpose are outlined in this specification.

Type II plating shall have a hardness of at least 110 diamond pyramid hardness.

III. Sampling and Testing

For inspection purposes, the sampling procedure outlined in this specification shall be used.

Separate specimens shall only be used for test specimens when so approved by the procuring agency.

Unless otherwise specified, the supplier shall be responsible for the performance of all inspection requirements prior to Government acceptance.

Adhesion shall be tested either by the bend test, by scraping the coating off the basis metal, or by baking the specimens for one hour at 275° ± 25°F. Whenever possible, the bend test shall be used.

Unless otherwise specified, no thickness requirements are to be met on surfaces which cannot be touched by a sphere 0.75 inch in diameter. Interior surfaces which can be touched by such a sphere shall meet thickness requirements only for a distance equal to the smallest dimension of the entrance to these surfaces.

This specification also defines and regulates plating at boundary areas, limiting significant surfaces.

Thickness measurements may be made by any method which will give a reading within plus or minus ten per cent of the true coating thickness.

The microscopic method shall be used as referee test, when performed in accordance with a procedure outlined in this specification.

IV. Note

Typical applications for the various thickness classes are given in the table below. This table is only for informational purposes and is not mandatory.

Thickness class	*Application*
1	Minimum gold plating, often used over silver underplating in electrical applications to prevent tarnishing.
2	For waveguides and contacts of multiconductor terminals where a nonmigratory material is required.
3	Standard coating for engineering use; for the same applications as class 2 requiring increased abrasion resistance.
4 and 5	For exceptionally heavy coatings resistant to corrosion and wear by handling.
6	For cathode emission characteristics.

V. History

This specification supercedes Military Specification MIL-G-14548A, dated November 3, 1959, as well as the Military Specifications MIL-G-14548 (Ord.) and MIL-G-19788 (NOrd).

Gray Plated Chromium

Military Specification MIL-C-11436 (SigC), dated September 10, 1951.

I. Scope

This specification covers requirements for gray plated chromium as a characteristically durable camouflage finish on aluminum, copper alloys, and steel.

II. Requirements

The chromium shall be deposited over undercoatings of copper and nickel on aluminum and ferrous metals, and over nickel only if the basis metal is cupreous.

The minimum thickness of the deposits shall be as follows:

Chrominum	0.00001″ minimum
Ni (over copper alloys)	0.0005″ minimum
Ni (on aluminum or steel)	0.0006″ minimum
Total Cu + Ni on aluminum or steel	0.00125″ minimum

The plating shall be uniform, continuous, and present a hard, flat-gray, corrosion-resistant finish.

If selective plating is required, the coating shall blend smoothly into the unplated surface.

The finish plated surface shall be cleaned cathodically, rinsed, dried by heat, and covered by a film of hot nonoxidizing petrolatum. Cathodically cleaned specimens shall withstand 100 hours of salt-spray exposure.

III. Sampling and Testing

For inspection purposes, the sampling procedure outlined in this specification shall be used, which consists in the selection of 27 test specimens.

Thickness, color, gloss, adhesion, and structural continuity shall be as outlined in this specification.

Tin Plating (Electrodeposited or hot-dipped) For ferrous and nonferrous metals

Military Specification MIL-T-10727A, dated May 20, 1959.

I. Classification

The tin plating shall be of the following types, as specified:

Type I — Electrodeposited
Type II — Hot-dipped

II. Requirements

The basis metal shall be substantially free from defects detrimental to the appearance or the protective value of the coating.

The minimum thickness of both types of coatings shall be as specified by the contracting agency.

When specified, coated items shall be able to withstand 24 hours of salt-spray exposure.

This specification also covers the solderability of the tin coating.

a) Type II coatings

The hot-dip tin bath shall be prepared using tin having a minimum tin content of 99.8%.

All ferrous and nonferrous metals shall be given a 2-to-5 minute treatment in a cold 15% (by volume) aqueous sulfuric acid solution containing 2% (by volume) nitric acid. After pickling and rinsing, all items shall be dipped in a flux solution composed of three pounds of zinc chloride and 0.3 pound of ammonium chloride per gallon of water.

In the case of brass or bronze basis metal, all stains shall be thoroughly removed with an acid dip or warm cyanide solution prior to coating.

III. Sampling and Testing

For inspection purposes, the sampling procedure outlined in this specification shall be used.

Adhesion shall be tested either by the bend test or by scraping the coating off the basis metal.

Separate specimens shall not be used for thickness measurements unless the necessity for their use has been demonstrated.

Unless otherwise specified, no thickness requirements are to be met on surfaces which cannot be touched by a sphere 0.75 inch in diameter. The plating on all other surfaces shall be of sufficient thickness to insure continuity and uniform utility, appearance and protection.

Thickness measurements may be made by gages, instruments or by means of the metallographic microscope as long as the method used will give readings within plus or minus 10% of the true coating thickness; the microscopic method shall be used for referee tests.

This specification also permits thickness determination by the chord thickness method and the coating weight method.

IV. Preparation for delivery

All tin plated parts specified as being used for electrical terminals which are to be soldered shall be given a protective coating or dip composed of one ounce of stearic acid dissolved in one gallon of xylol. This coating shall be applied, immediately after the plating, at room temperature.

V. Note

The various coating thicknesses are suggested for the following uses:

a.) 0.0001″-0.00025″ ....“flashing” of articles to be soldered.

b.) 0.0002″-0.0004″ .....to prevent galling or seizing.

c.) 0.0003″ min. .....to prevent corrosion of basis metals.

d.) 0.0002″-0.0006″ .....to prevent formation of case during nitriding.

VI. History

The above specification supercedes the following specification:

Military Specification MIL-T-10727 (Ord.) of November 28, 1950.

SCIENCE FOR THE COATINGS TECHNOLOGIST

(*Continued from page 60*)

a mill such as the ball mill, with its great shearing and impact forces, it is a fact that most coarse pigments have only a small proportion of extremely large agglomerates. By good pigment selection, and careful grinding and sorting by the pigment manufacturer, the majority of so-called coarse pigments can be handled in the sand grinder.

As the particle size becomes smaller, the nature of the difficulties changes. The surface area of the pigment increases to such an extent that it is sometimes not easy to find a vehicle which can wet the pigment sufficiently without at the same time producing too much cushioning action on the sand and too thick a layer of adsorbed binder on the pigment surface. Both of these effects reduce the shear.

In the case of very fine pigments, such as titanium dioxide, the problem is present, but can be overcome without too much difficulty. Extremely fine pigments, such as carbon blacks, are quite hard to handle. Extreme care must be used in the selection of the vehicle and in the formulation of the paste.

The sand grinder, then, is effective for pigments in the middle range. It is not useful for very coarse pigments or agglomerates; and is not ideal for extremely fine-sized pigments. But these are the extremes. Most of the pigments used in the paint industry fall between these limits. And most of the pigments used can be dispersed in the sand grinder in a very satisfactory way.

The machine is light-weight, easily installed, relatively inexpensive, and with relatively low power-demands. The productivity of finished paste is quite rapid, where the grinding paste has been formulated with care. Rates as high as 300 gallons per hour of whites have been claimed, from the 30-gallon size mill.

Bosse describes the sand grinder as being midway between the roller mill and the ball mill. It will not act like the ball mill, in that it cannot handle hard, coarse pigment agglomerates; and it will not act like the roller mill, which is efficient only on very high viscosity grinding pastes. But in the wide range in which it can be used with greatest effectiveness, it is a low-cost, highly efficient mill.

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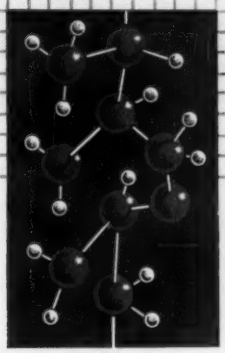

SYNTHETIC RESINS

The Backbone of Modern Finishes

A SURVEY OF THE LATEST DEVELOPMENTS IN SYNTHETIC RESINS USED IN COATINGS

Part X - Styrenated Alkyds

By Harold P. Preuss

IN the previous two articles in this series we discussed the role of Styrene-Butadiene and Polystyrene resins in making protective coatings. Styrene is also often modified by combination with alkyd resins.* Such resins are frequently referred to as "styrenated alkyds."

Styrenated alkyds became available commercially in 1948. These resins may be considered as a type of resin-modified alkyd to which the styrene confers better toughness, durability and paler color. Their principal advantage is their rapid drying characteristic.

Actually, styrene may be reacted with both straight and oil-modified alkyds to yield finishes that find use as thick one-coat lacquer replacements. The styrene content may run from 30 to 60 per cent. Long oil styrenated alkyds have been found to be excellent plasticizers for amine, vinyl and nitrocellulose lacquers. In general, styrenated alkyds are useful industrially as low cost finishes where fast drying and good protective qualities are desired.

Polystyrene is thermoplastic and may be softened by oils and some hydrocarbon solvents. The styrenated alkyds show this sensitivity, particularly if the degree of polymerization is low and the coatings are air dried. The sensitivity is decreased as the percentage of styrene is decreased or as the percentage of good drying oil in the alkyd component is increased.

Styrenated alkyds may be available in either mineral spirits or xylene solutions. For fastest setting and air drying, the xylene solution is better but, for grinding with pigments as well as best flow in high gloss finishes, the slower evaporating mineral spirits are preferred.

In general, the styrenated alkyds are not neutral to reactive pigments such as zinc oxide. In addition they are sufficiently reactive to iron metal so that they tend to body when ground in steel ball mills. Where use of small amounts of reactive pigments or of steel ball mills for production is essential, these reactions can in general be satisfactorily controlled through the addition of agents such as triethylamine or diethylamine in small quantities.

*A discussion of alkyd resins will commence with the next article in this series.

Styrenated alkyds have extremely limited compatibilities with most other types of resins, although in general they are compatible with each other. Products formulated with these resins, however, can be tinted with colors dispersed in oil. Amine type converting resins can be used to provide baking finishes.

Because of their fast solvent release, these resins are more adaptable to pebble and steel ball mill manufacture than to roller mills. In general, better gloss is obtained on pebble or ball mill production by following the so-called slush type grinding procedure. In this procedure the pigment is ground in a vehicle containing low vehicle solids, usually not over 20%. The enamel texture is usually attained within 16-24 hours grinding time, at which point additional resin is added to the mill and the mill run an additional several hours so as to properly wet the pigment with vehicle solids and prevent reagglomeration. At this point the mill can be drained and rinsed in the usual fashion.

Since the predominant influence in the wedding of styrene with an alkyd resin lies in the alkyd radical, we may consider the styrenated alkyds as being members of the polyester family, mentioned in the first article of this series (June, 1960).

Manufacturers of Styrenated Alkyds

In this article we will discuss styrenated alkyd resins used primarily for metal applications and made by the following nine firms in the U.S.A.:

Allied Chemical Corp., Plastics Division, New York 6, N. Y.

American Cyanamid Co., Plastics and Resins Division, New York 20, N. Y.

Archer-Daniels-Midland Co., Minneapolis 40, Minn.

Cook Paint & Varnish Company, Kansas City 41, Mo.

France, Campbell and Darling, Inc., Kenilworth, N. J.

Freeman Chemical Corp., Subsidiary of H. H. Robertson Company, Port Washington, Wis.

Jones-Dabney Co., Division of Devoe & Reynolds Co., Inc., Louisville, Ky.

Reichhold Chemicals, Inc., White Plains, N. Y.

Schenectady Resins Division, Schenectady Varnish Co., Inc., Schenectady, N. Y.

Physical and chemical properties of the individual resins discussed may be found in Table I.

Allied Chemical

Plaskon Coating Resin 3801 is a styrene-alkyd copolymer supplied by Allied Chemical Corporation as a viscous solution in xylol. Rapid speeds of drying or curing may be achieved with air drying or baking finishes based on this resin. Pigmentation with full colors or white is easily accomplished and brilliant hammer finishes with uniformity of pattern are readily obtainable with the styrene modified resin.

American Cyanamid

The Plastics and Resins Division of American Cyanamid manufactures a series of styrene-alkyd copolymer resins under the trade name *Cycopol*:

Resin S-101-1 offers a combination of drying speed, toughness, adhesion and color retention said to be unusual in a petroleum spirits soluble resin vehicle. It may be used in the formulation of air dry white or colored enamels for application by brush, spray, roller coat or dip.

Resin S-102-5 has a drying speed much faster than that of Cycopol S-101-1. Finishes formulated with this product approach the speed of nitrocellulose lacquer and the gloss of oleoresinous enamels. Spraying is the best method of application. Enamels may be reduced with equal parts of aliphatic and aromatic hydrocarbons.

Resin S-102-5HV is a special grade of resin S-102-5 recommended particularly as a vehicle for "hammered" metallic finishes. With S-102-5HV the formulator may produce a variety of hammer patterns over a wide range in enamel viscosity. Other important factors in obtaining the type of pattern desired are atomization pressure and the solvency of the reducing solvent. In addition to "hammered" finishes, this resin may be used in applications where it is desirable to have higher resin viscosity than obtained with S-102-5.

Resin S-201-1 is a petroleum spirits soluble styrene-alkyd copolymer recommended for use in fast drying trade sales and industrial finishes. The characteristics and film properties of S-201-1 are comparable to those of S-101-1.

Resin 320-5 is a fast drying copolymer. Coatings formulated with 320-5 dry with lacquer speed and develop early resistance to alipathic hydrocarbon solvents. They have very good adhesion, hardness, chemical resistance and gloss. Suggested applications for 320-5 include industrial enamels, automotive finishes, machinery enamels, floor finishes, and toy enamels.

Resin 341-17 is a fast drying copolymer resin combining very fast drying speed with excellent solubility in alipathic solvents. When reduced below 30% vehicle solids, 10% xylol based on total solvent is advisable to avoid stratification at low temperatures. In view of its drying speed and solvency characteristics, resin 341-17 is suggested for paper coatings, polystyrene coatings, implement enamels traffic paints.

Archer-Daniels-Midland

This company designates its two short oil, styrenated, alkyd solution resins as *Aropol 879-X-60* and *Aropol 890-X-60*. Both have exceptionally fast dry coupled with good film hardness in air dry and baked films. Chemical resistance is very good, being superior to alkyds in alkali, acid and water resistance. Mar resistance and solvent resistance are not of the highest order.

Aropol 879-X-60 is suggested for use in low sheen quick drying enamels and many varied industrial applications where extremely fast dry is required, such as finishes for toys, metal furniture and hardware.

Aropol 890-X-60 is suggested for use in hammer finishes, lusterless quick drying enamel, as well as in applications where Aropol 879-X-60 is used. It has a higher viscosity than Aropol 879-X-60.

Cook

Two styrene modified dehydrated castor oil alkyd resins are manufactured by Cook Paint and Varnish Company under the general trade name of *Coroc*. These are as follows:

Resin *RC-3772-A2* is useful in rapid air dry and baking enamels, hammer effect enamels, dipping enamels and primers. It dries to a hard tough flexible film. Adhesion and exterior durability are both good. Minimum discoloration is found in baked hammer effect enamels or conventional industrial finishes.

Resin *RC-3772-H7* is recommended as a coating resin for dip and flow coat applications. This is the same base resin as RC-3772-A2 but cut in a slow boiling, high solvency aromatic solvent. It is especially good for all roller coat applications.

In addition, this company makes the following styrene modified alkyd resins:

Resin *RL-4214-M* is a styrene modified linseed oil alkyd used for fast air dry industrial enamels, implement enamels, and baking primers. This low cost resin can be used for almost any industrial application where rapid air dry characteristics are desired.

Resin B-7445-M is a styrene modified soya alkyd. It is used in rapid air dry and low temperature baking industrial enamels. In combination with medium oil alkyds or by itself, this resin dries extremely fast. It has high gasoline resistance and excellent spraying characteristics.

Resin B-7918-H7 is a styrene modified alkyd copolymer used in baking enamels, coating whites and various roller coatings. The resin cures very quickly to a hard, tough, and process resistant coating. It is an excellent vehicle for can coatings and other metal products.

France, Campbell and Darling

This New Jersey firm produces a large family of alkyd type resins, one of which is of the alkyd-styrene type. It is known as *FCD 660* and is suggested for use in architectural flat finishes and floor sealers. Finished films are scrubbable and resistant to acids, fats, water

TABLE I

PROPERTIES OF STYRENE-ALKYD COPOLYMER RESINS

MANUFACTURER	RESIN	POUNDS PER GALLON	%SOLIDS	SOLVENT	VISCOSITY (G-H@25°C)	COLOR, GARDNER '33	ACID VALUE
COOK	RC-3772-A2	8.13	49-51	XYLOL	U-V	7-9	5-10
	RC-3772-H7	8.13	49-51	H.S. AROMATIC	X-Y	6-8	8-10
	RL-4214-M	7.55	49-51	90% V.M.&P. 10% XYLOL	Z-Z_1	6-8	8-10
	B-7445-M	7.60	49-51	50% V.M.&P. 50% XYLOL	X-Z	4-6	4-8
	B-7918-H7	8.10	49-51	HIGH BOILING AROMATIC	S-U	2-5	6-10
ALLIED CHEMICAL	PLASKON 3801	7.9-8.0	50	XYLOL	W-Y	3-6	1.5-3.5
FRANCE, CAMBBELL AND DARLING	FCD660	8.2	59-61	XYLOL	Z_1-Z_4	4-8	2-5
JONES-DABNEY	STYRETEX 310	8.12	60	XYLOL	Z_2-Z_4	5	8-13
	STYRETEX 311	8.22	60	XYLOL	U-W	6	6-10
	STYRETEX 312	8.10	60	XYLOL	Z_1-Z_3	5	5-10
	STYRETEX 317	8.15	60	XYLOL	Z_1-Z_3	6	8-12
	STYRETEX 321	7.65	50	30% HVY. ARO. NAP. 70% MIN. SP.	Z_1-Z_3	6	6-10
FREEMAN	CHEMPOL 13-2401	8.3	60	XYLOL	Z_2-Z_4	8(MAX.)	5-7
	CHEMPOL 13-2200	8.2	60	XYLOL	Z-Z_3	7(MAX.)	4-7
REICHHOLD	STYRESOL 4240-45	7.77-7.86	44-46	TOLUOL	Q-S	3-6	3-7
	STYRESOL 4250-50	8.00-8.09	49-51	XYLOL	S-U	2-5	4-8
	STYRESOL 4250-50-HV	8.00-8.09	49-51	XYLOL	U-V	2-5	4-8
	STYRESOL 4252-50	8.00-8.09	49-51	XYLOL	T-V	2-5	4-8
	STYRESOL 4255-50-LV	7.29-7.37	49-51	V.M.&P. NAPHTHA	V-X	2-5	3-7
	STYRESOL 4400-50	8.02-8.11	49-51	XYLOL	R-T	3-5	4-8
	STYRESOL 4440-50	7.79-7.87	49-51	H.S. MINERAL SPIRITS	Z_1-Z_3	6-9	3-8
	STYRESOL 4445-50	7.54-7.62	49-51	MINERAL SPIRITS	Z_1-Z_3	6(MAX.)	6-12
AMERICAN CYANAMID	CYCOPOL S 101-1	7.7	50±1	PETROLEUM SPIRITS	Z_1-Z_4	3-6	3-8
	CYCOPOL S 102-5	8.2	60±1	XYLOL	Z_1-Z_3	3-6	2-5
	CYCOPOL S 102-5HV	8.2	60±1	XYLOL	Z_2-Z_4	3-6	2-5
	CYCOPOL S 201-1	7.7	50±1	PETROLEUM SPIRITS	Z_1-Z_3	5-8	4-10
	CYCOPOL 320-5	8.0	50±1	XYLOL	X-Z_1	9-12	4-8
	CYCOPOL 341-17	7.2	50±1	V.M. & P. NAPHTHA	W-Z	4-8	6-12
ARCHER-DANIELS-MIDLAND	ARDPOL 879-X-60	8.3	60±1	XYLOL	Z-Z_2	8(MAX.)	8(MAX.)
	ARDPOL 890-X-60	8.3	60±1	XYLOL	Z_3-Z_5	8(MAX.)	10(MAX.)
SCHENECTADY	SSA-42	8.2-8.4	60±2	XYLOL	Z_1-Z_2	1-2	4-8
	SSA-46	7.6-7.8	50	V.M.&P.	Z-Z_2	1-2	4-8

and weather. It air dries to a hard finish in five hours.

FREEMAN

A sizeable family of alkyd and alkyd modified resins are made by this firm under the trade name *Chempol.* Two of these resins are of the styrenated alkyd variety.

Chempol 13-2401 is an aromatic-soluble, styrenated alkyd suitable for rapid air dry and baking industrial finishes. Enamels formulated with this resin cure very rapidly over a wide range of temperatures to hard tough films. These enamels have excellent water resistance, gloss, color, durability and chemical resistance.

Chempol 13-2200 is a specially formulated resin designed to gain the maximum in gloss and flexibility. It possesses lacquer speed of dry and has maximum color retention. Its best feature is its high gloss and its unusually good flexibility.

JONES-DABNEY

Five styrenated alkyds are made by Jones-Dabney Co. under their general trade name *Styretex*:

Styretex 310 is designed primarily for industrial applications where its lacquer-like speed of dry would suggest its use for fast drying primers, undercoaters, gloss enamels and shop coats. It gives excellent results when used as the vehicle for hammer finishes, both bake and air dry types. It also exhibits excellent hardness, toughness and outstanding exterior durability, being in the same class as a medium length pure alkyd resin in this respect. It has good wetting and grinding properties with most pigments, and its excellent color and color retention properties make it particularly desirable for use in the formulation of most types of fast drying white finishes.

Styretex 311 is a linseed oil, glycerol-phthalate styrenated alkyd. It has excellent speed of dry, good water resistance, flexibility, and weathering properties to make it quite suitable for use in industrial applications such as primers, shop coats, etc. Being longer in oil, this resin has good flexibility but will, of course, be somewhat slower in initial dry.

Styretex 312 is offered as a castor-free replacement for Styretex 310. It is intended for the same types of industrial applications, namely, fast drying primers, undercoaters, gloss enamels, as well as for both baking and air drying hammer finishes.

Styretex 317 was developed as a result of efforts to eliminate one of the basic weaknesses of the styrenated alkyds, namely recoating. At the same time, due to an ester gum modification, a more economical resin was achieved. This resin retains most of the desirable characteristics of Styretex 310 and Styretex 312, with the additional advantage of slightly higher gloss in most enamel formulations. It also exhibits sharper, more distinct hammer patterns. Because of a tendency for formulations containing butanol to lose viscosity in the package on storage, use of this solvent with Styretex 317 should be avoided or kept to a minimum.

Styretex 321 exhibits a high degree of tolerance for aliphatic solvents. It is a clear, bright resin designed for brush or spray application. The solvent lineup of this resin suggests its use in brushing enamels, primers, undercoaters, sealers and shop coats. For the same reason it is readily adaptable to roller mill grinding where solvent evaporation loss must be held to a minimum.

REICHHOLD

One of the early producers of styrenated alkyd resins, Reichhold today produces eight variations under the general trade name *Styresol:*

No. 4240-45 solution is recommended for use in primers, implement enamels, toy enamels, industrial enamels (air drying and baking), hammered finishes and paper coatings. Outstanding properties include durability, adhesion, gloss, gloss retention, hardness and fast drying. Suggested thinner proportions are 85% petroleum and 15% coal tar solvents.

No. 4250-50 solution has the same general uses and properties as the preceding resin. Differences in its properties may be learned by reference to Table I. Suggested thinner is 100% coal tar solvents.

No. 4250-50-HV solution again has similar uses and properties as the No. 4240-45 solution mentioned previously, but comes in a higher viscosity and is suggested for thinning with 100% petroleum solvent.

No. 4252-50 has similar uses and properties to the above resins, but in addition possesses a fast tape time. Suggested thinner is 100% coal tar solvent.

No. 4255-50-LV has a slightly higher viscosity than No. 4252-50 resin; the solvent suggested is 100% petroleum. It has a good color retention and mineral spirits tolerance. Other properties and uses are similar to those described above.

No. 4400-50 solution has a slower air drying time than the foregoing resin; the thinner suggested is 100% coal tar. Other properties and uses are similar to those described above.

No. 4440-50 solution is recommended for use in 4-hour enamels, as a grinding medium for No. 4250-50 and No. 4400-50 Styresols, in toy enamels, and industrial enamels. It has a high viscosity; suggested thinner proportions are 85% petroleum and 15% coal tar solvents.

No. 4445-50 solution is suggested for interior quick drying enamels, trailer finishes, and as a roller mill grinding vehicle for styresol enamels. Outstanding properties include compatibility, rapid dry, durability, color, gloss retention and mineral spirits tolerance. Suggested thinner is 100% petroleum solvent.

SCHENECTADY

Two alkyd styrene copolymer solution resins are made by this company, as follows:

SSA-42. This resin is designed for very fast drying finishes having excellent color, gloss, adhesion, toughness and durability. It may be used with normal amounts of melamine resins for greater hardness and chemical resistance.

SSA-46. This is a mineral spirits-soluble resin that

(*Continued on page* 69)

FINISHING POINTERS

DETERMINATION OF ZINC IN NICKEL ELECTROLYTES

By Larissa Domnikov
Process Analyst A, Norair Division, Northrop Corp.

A METHOD of zinc determination developed by V. I. Kuznetsov and based on the color change of methyl violet indicator in the presence of zinc has been successfully adapted by the researchers at Moscow Polygraphic Institute for the analysis of zinc in nickel electrolytes.*

The reaction sensitivity of methyl violet indicator with zinc can be considered as 0.0005%; this value is ten times smaller than the zinc concentration allowable in nickel electrolytes (0.005% Zn).

To prevent the green color of nickel solution from interfering with the zinc analysis, the concentrations of the indicator and ammonium thiocyanate were increased. A standard nickel bath was used for the test analysis, containing 250 g./l. $NiSO_4 \cdot 6H_2O$; 20 g./l. NaCl and 20 g./l. H_3BO_3; the pH of the solution was 5.0-5.5. The following impurities were introduced into the electrolyte: 0.6 g./l. $ZnSO_4 \cdot 7H_2O$; 3 g./l. $FeSO_4 \cdot 7H_2O$; 0.35 g./l. KNO_3, and 1.5 g./l. $CuSO_4 \cdot 5H_2O$.

Method of Analysis

In a test tube are mixed 25 drops of water, 5 drops of a saturated tartaric acid solution, 2 drops of hydrochloric acid (spec. gravity 1.2), 4 drops of a 20% solution of ammonium thiocyanate, and 6 drops of a 0.06% solution of methyl violet indicator. The contents of the test tube are divided into three portions; one is retained for comparison purposes, into the second two drops of nickel solution are added. If the bath contains zinc, the bluish-green color of the solution will change to violet, or blue with small zinc concentrations. The change of color to violet or blue indicates that the solution contains zinc in an amount equal or exceeding 0.0005%.

To determine whether the zinc concentration does or does not exceed the allowable value, the sample taken from the bath is diluted to one tenth of its original strength, and 2 to 3 drops of this diluted solution are added to the third test tube with the reagent. The change of color from greenish-blue to violet indicates that the concentration of Zn^{++} is 0.005% and the plating solution requires a purification treatment.

For *quantitative* zinc determination, the reagent is freshly prepared and divided into three portions. The plating solution is diluted to one twentieth, one thirtieth, and one fortieth of its original strength, and the analyses are run. If the color change is detected with the one thirtieth dilution and is not observed with the one fortieth dilution, then the zinc concentration in the bath is 0.0005 × 30 = 0.015%. (See Table.)

TABLE

Reaction Sensitivity of Methyl Violet Indicator With Zinc

Zn Conc.	*Color*
1.0	Voilet
0.5	Violet
0.1	Violet
0.05	Violet
0.01	Violet
0.005	Violet
0.001	Violet-blue
0.0008	Violet
0.0006	Blue
0.0005	Light-blue
0.0004	Faintly blue
0.0003	No change of color
0.0002	No change of color

*I. P. Kliachko, A.D. Vinogradova, *Zavodskaia Laboratoria* (Plant Laboratory), No. 5 (1958).

SYNTHETIC RESINS

(*Continued from page* 68)

may also be used with normal amounts of melamine resins for greater hardness and chemical resistance.

One of the outstanding features of these resins is their light color. Their most common applications are for fast drying enamels, metal lithography, industrial enamels and can coatings.

Discussion

Styrenated-alkyd copolymer resins, generally speaking, dry with lacquer speed but solid concentrations are much higher than with lacquers. Films tend to be brittle and they have poor exterior durability. However, for machinery, toys, as well as other applications mentioned in this article, their low cost and fast air dry make them very useful.

As indicated in the footnote on the first page of this article, Part XI of this series, commencing next month, will deal with Alkyd Resins, which comprise by far the most important coatings resins in use, volume-wise far surpassing their nearest competitor.

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3. Organic Coating Technology. Vol. I. By Henry Flemming Payne. John Wiley & Sons, Inc., New York, N. Y. 1954.
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Science for Electroplaters

66. Nickel - Hardness Tensile Strength

By L. Serota

This is the second half of Part 66 of this series. The first half appeared in the July issue.—Ed.

Effect of Bath Variables

THE extensiveness of measurements made for hardness, tensile strength, and elongation of nickel deposits indicates the practical value and importance of these properties. Such values, it has been found, for both as plated and annealed deposits, are correlated. Accordingly, hardness measurements of nickel deposits, which are relatively rapid and simple to perform, may be used as an estimate for obtaining the other two mechanical properties, tensile strength and elongation. That a linear relation exists between hardness and tensile strength and an inverse relation between these properties and elongation was emphasized by A. Brenner, V. Zentner & C. W. Jennings as a result of their study of the physical properties of electrodeposited nickel. This relationship for all plating solutions studied is effectively shown in Fig. 3 which represents graphically the data for various plating solutions under different conditions, including heat-treated deposits.

A. Brenner & C. W. Jennings give the following range in values for electrodeposited nickel: hardness, 120 to 550 Brinnell; tensile strength 50,000 to 200,000 psi; elongation 1 to 30 per cent.

pH

The effect of pH upon the mechanical properties, hardness, tensile strength, and elongation, is pronounced. Appreciable changes in such properties occur with variations in pH. Its influence, accordingly, provides effective means of producing electrodeposited nickel of desired hardness and structure.

E. J. Roehl, in his study of mechanical properties of nickel deposits, shows graphically (Fig. 4) how hardness, tensile strength, and elongation in deposits are affected by changes in pH for both as-plated and heat-treated deposits in a Watts type bath: $NiSO_4 \cdot 7H_2O$, 325 g./l.; $NiCl_2 \cdot 6H_2O$, 45 g./l.; H_3BO_3, 30 g./l.; operating at 130°F., current density 40 or 50 amp./ft.^{2}, depending upon the pH of the solution.

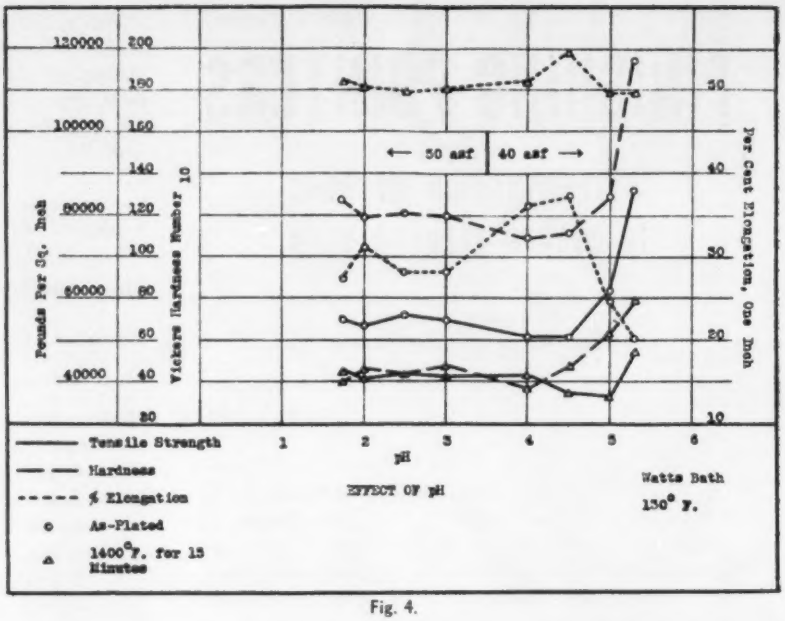


Fig. 4.

A revealing factor indicated in the graph is the critical pH value pertaining to hardness (and tensile strength). Little variation in such properties, it will be noted, results with pH range increase from 1 to 5. A pronounced increase in hardness and tensile strength of the deposit occurs, however, when the pH rises above the value of 5.0. The minimum hardness and tensile strength, it will be noted, is obtained at a pH of about 4. Elongation shows a decrease under the above condition with the maximum value obtained at a pH of about 4.5.

Comparable results showing such relationship between the three mechanical properties were reported by other investigators. V. Zentner, A. Brenner & C. W. Jennings indicate graphically in their results (Fig. 5 curve 1) the same pronounced increase in hardness as that obtained by Roehl when the pH value rises above 5, in a Watts type bath, as well as the minimum in hardness (and tensile strength) when the pH is 3 to 4.

The dotted curve, marked 3, represents the combined (composite) re-

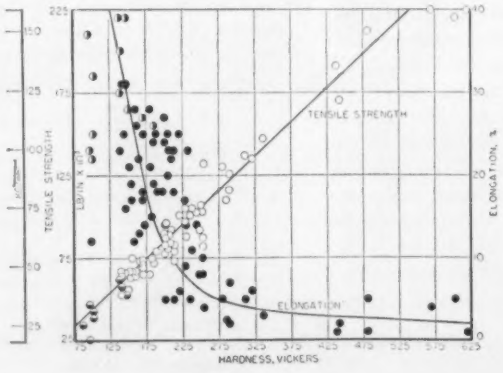


Fig. 3. General relation of hardness to tensile strength and elongation of nickel deposits. Data represent all types of plating solutions and plating conditions, including heat-treated deposits. Clear circles indicate hardness and tensile strength; dark circles indicate hardness and elongation; half-shade circles indicate heat-treated deposits.

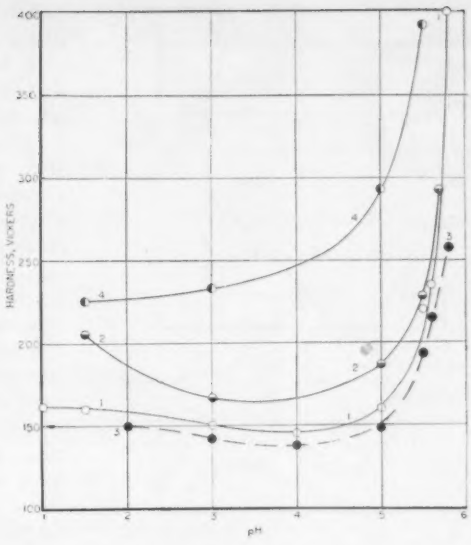


Fig. 5. Effect of pH of plating solutions on hardness of nickel deposits. Curve 1—55°C. (131°F.) and 5 amp./dm.^{2} (46 amp./ft.^{2}); Curve 2—Baths at various temperatures and current densities; Curve 3—Composite data from McNaughtan and Hammond, McNaughtan, Gardam and Hammond, and Roehl; Curve 4—55°C. (131°F.) and 5 amp./dm.^{2} (46 amp./ft.^{2}).

sults of a number of investigators, namely Roehl, McNaughton & Hammond, as well as McNaughton, Gardam & Hammond. This curve, corresponding to the hardness of nickel deposits from solutions similar in composition to that represented by curve 1, indicates clearly, by the parallel trend, the agreement with curve 1. Similar values were obtained with this composite data for tensile strength and elongation.

Curve 2 in Fig. 5 refers to the Watts type baths containing sodium sulfate or ammonium sulfate at various temperature and current densities. Here, too, a minimum for hardness is evident. Curve 4, however, representing averages for hardness (and tensile strength) for deposits from baths with high chloride concentrations, operating at 55°C., 46 amp./ft.^{2} does not show, like the other solutions, a minimum; instead a steady increase in hardness with increasing pH is indicated.

Current Density

The effect of current density upon the mechanical properties of deposits from the Watts bath at a pH of 2.0 and at a pH of 5.0 was also reported by Roehl. Variations in current density from 10-50 amp./ft.^{2} at a pH of 2.0, 130°F., it was found, have virtually no effect upon the mechanical properties for both the as-plated and annealed at 1400°F. for 15 minutes (Fig. 6). When the same type of solution was operated, however, under the same conditions of current density and temperature at a pH of 5.0, ductility (elongation) remained fairly constant but hardness and tensile strength showed a decrease with increasing current density (Fig. 7).

Data obtained by A. Brenner and associates in their study of the effect of variations in current density upon the mechanical properties of deposits from a Watts bath for a number of different conditions, with pH values ranging from 1.5 to 5.0, show little variation in hardness except at low current densities (2 amp./ft.^{2}), where the increase in hardness of the deposit is pronounced. The grain structure of the deposit at the very low current density, photomicrographs showed, is much finer than that of deposits obtained at higher current densities. Insufficient data were accumulated, the authors note, to report on the effect of current density variations on tensile strength and elongation.

Temperature

The influence of temperature upon hardness, tensile strength and elongation for the as-plated deposits from the Watts bath, based upon data obtained by Roehl at a pH of 2.0 (50 amp./ft.^{2}) and also at a pH of 5.0 (40 amp./ft.^{2}.) is effectively indicated graphically in Fig. 8. A decided decrease in hardness and tensile strength results, it will be noted, with increase in temperature when operating at a pH of 2.0, with the greatest values for hardness and tensile strength obtained at 85°F.

The effect of solution temperature on the structure (grain size) of the deposit for the Watts bath solution, indicated in Fig. 8, at pH 2.0 is demonstrated by photomicrographs of deposits taken at 85°F. and 170°F. (Fig. 9). The finer grain size of the deposit, corresponding to the lower temperature (85°F.) is clearly evident. Ductility (elongation), however, increases with increasing temperature.

Results for pH 5.0 show that, while the same relationship prevails at pH 5.0 as that at pH 2.0, the effects are not so pronounced at the higher pH.

Chloride Content

Varying the nickel chloride content of a bath containing nickel sulfate, with the nickel content remaining constant (62 g./l.) gave best results in

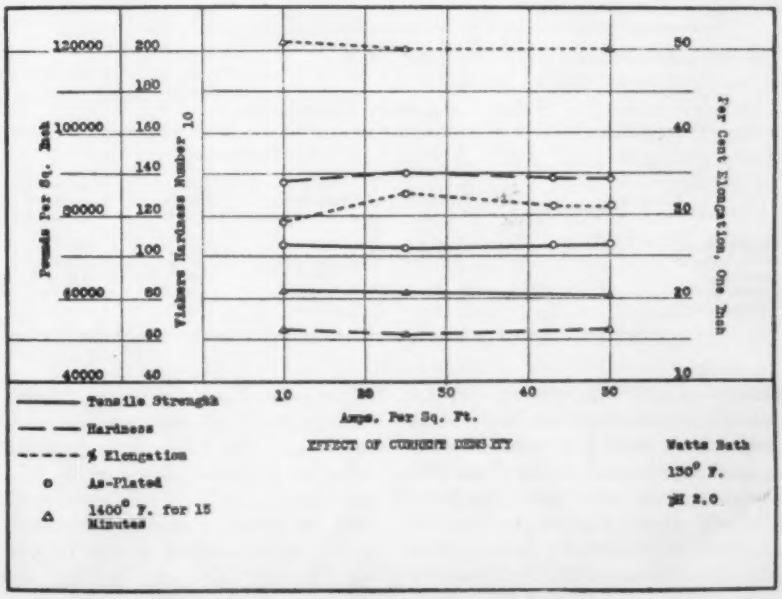


Fig. 6.

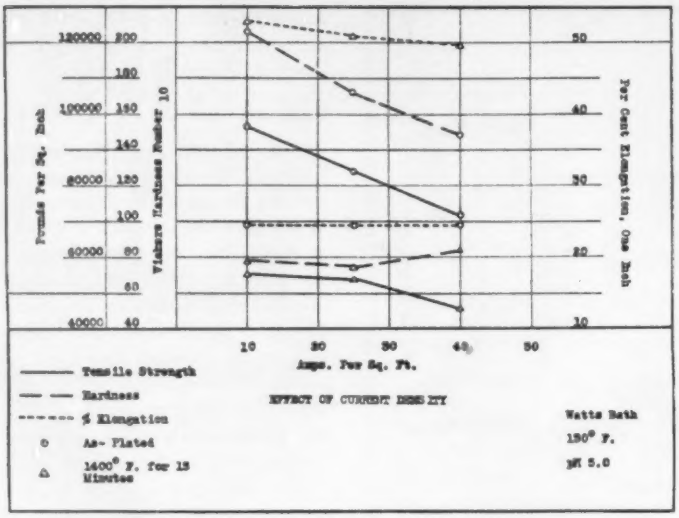


Fig. 7.

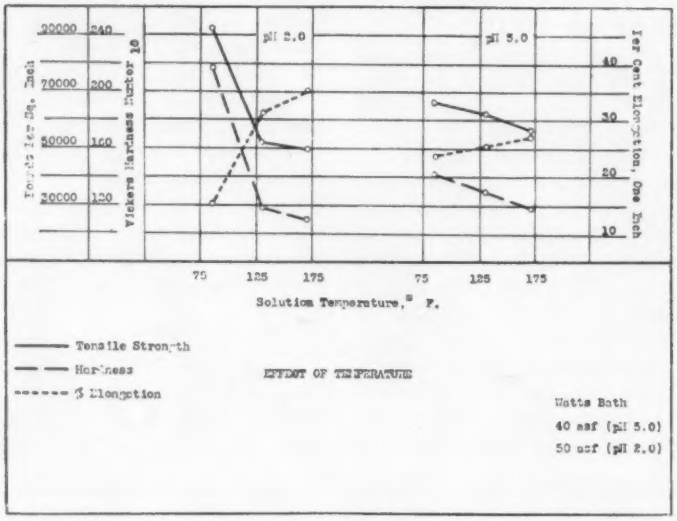


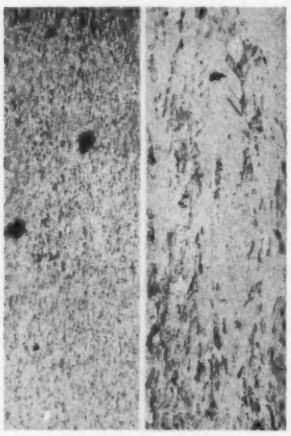
Fig. 8.

TABLE I. SOLUTION COMPOSITION

Constituents	Concentration, g./l.			
	Standard	Low-Boric-Acid	Low-Chloride	Low-Total-Composition
Nickel sulfate	325	325	325	163
Nickel chloride	45	45	11	22
Boric Acid	30	10	30	15
Nickel (as Ni)	79.3	79	69	39
Chloride (as Cl)	13.4	13.6	3.2	6.6

plating quality. W. Tucker reports that, when the nickel chloride content ranged from 30-60 g./l. nickel chloride as well as 250 g./l.-217 g./l. respectively of single nickel salts, the hardness and appearance of the deposits from the solutions, he found, were practically the same. The hardness values recorded were 20.0 and 20.5 sclero-scope units. When the nickel chloride content in the solution was increased to 120 g./l. plus 150 g./l. single nickel salt, the hardness increased to 27.5 (scleroscope) with a minimum tendency for pitting occurring. Bath operations were conducted at 120°F., current density 32.4 amp./ft.^{2} for 460 minutes at a pH of 5.2 to 5.25.

When the concentration of the single nickel salt was kept constant, at 240 g./l. but the nickel chloride content varied, good plates were obtained from all solutions. A very smooth plate, exhibiting a tough, fine grained deposit with greatest hardness value, 33.3 (scleroscope), was obtained when the solution contained 120 g./l. nickel chloride. Chloride ions, Tucker concludes, tend to increase hardness, and anode corrosion, decrease crystal size. Operating conditions were the same as those employed in the former nickel salt concentrations. Nickel content, boric acid, and sulfate ions in a Watts type bath had little effect upon hardness, Tucker found. A comparative study was made by E. J. Roehl of hardness of nickel deposits under varying pH values, using low chloride and boric acid concentrations, as well as a low total composition and a standard



85°F. 170°F.

Fig. 9. Effect of bath temperature on structure of nickel deposited in a Watts type bath of pH 2.0 at 50 asf. × 100.

Watts solution. The solution composition indicating the variants is shown in Table 1. Roehl found that a minimum hardness was obtained at a pH of 4.5 for the low chloride low-boric acid and standard baths and a maximum hardness of 214 Vickers for the standard at a pH of 5.3. The graph is represented in Fig. 10. The dilute or low composition bath, however, showed a maximum hardness at a pH of 4.0. The standard and low chloride baths showed a maximum ductility, 37 per cent elongation, at a pH of 4.5, dropping rapidly with increasing pH. The dilute bath showed the lowest ductility, the minimum indicated in the region of pH 4 to 4.5.

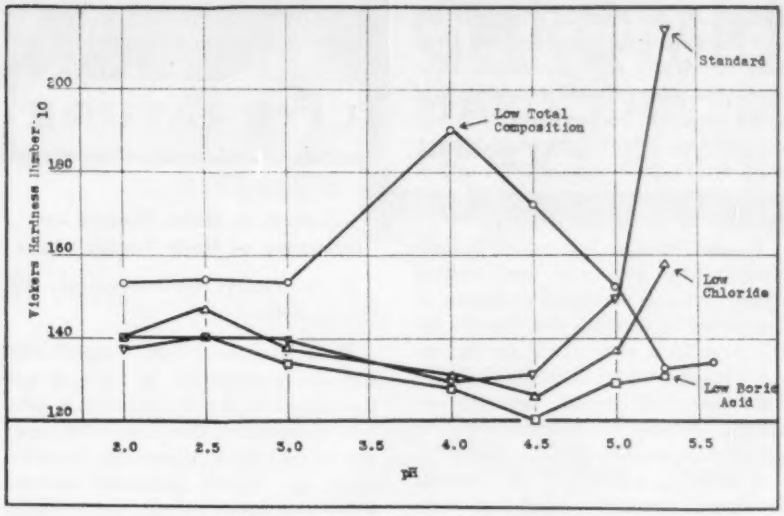


Fig. 10. Effect of pH on hardness of as-plated deposits.

A. Brenner and associates also obtained a maximum and minimum in hardness of nickel deposits for variations in chloride content of the nickel bath. Significantly, a pronounced minimum in hardness (and tensile strength) was indicated for the chloride content representing the average of deposits of 5 baths and 35 plating conditions, a chloride value corresponding to that recorded for the chloride content of a Watts type solution.

Results, with hardness data plotted as a function of chloride content, are represented graphically in Fig. 11. The elongation for the deposits showed a maximum at the same point in the graph (25 per cent nickel as nickel chloride) where a minimum in hardness was obtained.

D. J. McNaughton, G. E. Gardam & R. A. F. Hammond also reported, in their investigation of the electrolyte and nickel deposits, that the chloride ion in low pH nickel solution tends to induce formation of soft nickel deposits.

Hard Nickel Deposits

Nickel deposits with a hardness of 380 to 480 Vickers, of sufficient thickness to meet industrial specifications, was obtained by W. A. Wesley from a bath consisting of $NiSO_4 6H_2O$, 180 g./l.; NH_4Cl, 25 g./l.; H_3BO_3, 30 g./l. With the higher chloride composition of this bath permitting greater anode current density at high anode efficiency, and the boric acid providing adequate buffering action, a constant pH of the bath can be maintained. This bath differs from the bath prepared by D. J. McNaughton & A. W. Hothersall by the elimination of potassium as the chloride, which they included in the bath together with the double nickel salt. Heavy deposits obtained from this bath are found to be free from lamination. The effect upon hardness for deposits obtained under varying conditions of pH and temperature, at a current density of 50 amp./ft.^{2}, is indicated graphically in Fig. 12.

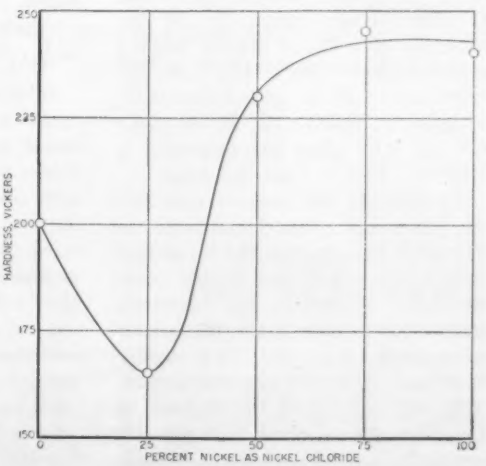


Fig. 11. Effect of chloride content of plating bath on hardness of nickel deposits. Each point represents the average hardness of 5 to 10 deposits each produced under different conditions of plating. Temperature range — 30° to 80°C. (86° to 176°F.); Current density range — 2 to 5 amp./dm.^{2} (19 to 46 amp./ft.^{2}); pH range — 1.5 to 5.0.

Annealing

Heat treated (annealed) deposits of hard nickel will show a decrease in hardness and tensile strength and, usually, an increase in ductility. A. Brenner & C. W. Jennings note that a drop in hardness of 100 points (Brinnell) results when the deposit is annealed at 300°C. This change is attributed to insufficient oxide inclusion in the grain boundaries to restrict recrystallization and grain growth.

Recrystallization, they found, occurred under heat-treatment at 1000°C. (1832°F.). For example, a photomicrograph of the structure of nickel deposited from a Watts type bath operating at 55°C., 5 amp./dm.^{2} (46 amp./ft.^{2}), pH 4.3, showed a columnar grain structure (Fig. 13). When the nickel deposit was annealed at 1000°C. for one hour, large equiaxed grains (Fig. 14), which the authors associate with the annealed material, were evident.

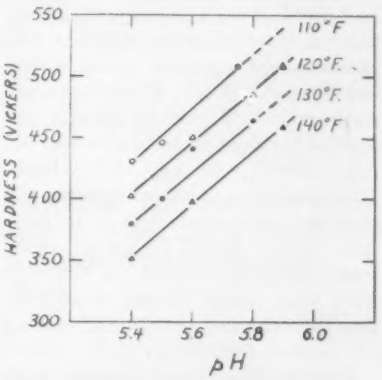


Fig. 12. Hardness of nickel deposits from modified bath. Cathode current density: 50 amp./ft.^{2} (5.4 amp./dm.^{2}).

In one instance, the authors report, an annealed sheet of nickel became brittle. This effect J. W. Cuthbertson suggests, is due to the segregation of material inherently present in the deposit, which collects at the grain boundaries. Gardam & McNaughton showed that basic material segregates in electrodeposited nickel on annealing, and that annealing brittleness in deposits is most pronounced in deposits in which preferred orientation normal to the surface of the cathode exists.

Fig. 13. Bath at 55°C. (131°F.), 5 amp./dm.^{2} (46 amp./ft.^{2}), and pH 3.0 X 200.

E. J. Roehl found that the structure of the nickel deposited in a Watts type bath, 130°F., 50 amp./ft.^{2}, at different pH values, changed when annealed at 1400°F. for 15 minutes. Recrystallization from columnar structure into medium-sized equiaxial grains occurred through pH 3.0. When heat-treatment at 1400°F. for 15 minutes was applied for deposits from a bath at pH 5.0, (130°F., 40 amp./ft.^{2}), Roehl found retention of the columnar structure and some crystallization to polygonal grains. At this higher pH (5.0), recrystallization started at 1200°F. Very large grains formed at 1550°F. Ductility showed pronounced falling off between 1500°-1550°F.

Deposits from the Watts type bath at pH 4.5, with an as-plated ductility of 37.3 per cent elongation in one inch, increased to a high value of 54.6 per cent elongation when the deposit was annealed for 15 minutes at 1400°F. At this annealing temperature and time, elongation for deposits from both the Watts and all-chloride solutions was raised, Roehl reported, to a value of about 50 per cent. This was independent of pH, current density, temperature, and composition. Overannealing resulted in a decided loss of ductility of the nickel deposits.

Fig. 14. Bath at 55°C. (131°F.), 5 amp./dm.^{2} (46 amp./ft.^{2}), and pH 3.0 X 250. Deposit heated at 1000°C. (1832°F.) for one hour.

Zentner, Brenner & Jennings, in their study of the effect of heat-treating nickel deposits, prevented oxidation of the nickel by heating the deposit for one hour in a vacuum. At an annealing temperature of 400°C. (752°F.) little change in crystal structure occurred. When the temperature was raised, however, to 600°C. (1112°F.) and 1000°C. (1832°F.) all deposits developed structures exhibiting equiaxial grains, the suggestion being made that the bulk of the non-metallic impurities were probably segregated in the well-defined grain boundaries. This effect is readily discernible in the photomicrograph (Fig. 15) of the structure of a nickel deposit from a sulfate-chloride bath (9.5 oz./gal. $NiSO_4 \cdot H_2O$; 24 oz./gal. $NiCl_2\,6H_2O$; 4 oz. oz./gl. H_3BO_3, 131°F., 46 amp./ft.^{2}, pH 3.0) after heat-treatment at 1000°C. (1832°F.) for one hour.

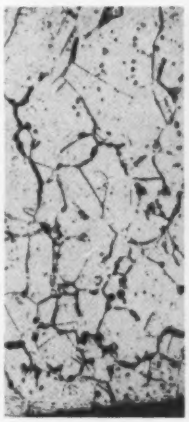


Fig. 15. Heat-treated at 1000°C. (1832°F.)

Fig. 16. Heat-treated at 1000°C. (1832°F.)

By contrast, the authors note that the grain and grain boundaries for the nickel deposit from the Watts type bath, operated and heat treated under the same conditions are relatively clean. This is indicated in the photomicrograph (Fig. 16). This deposit contained about 0.01 per cent oxygen, whereas, the deposit represented in Fig. 15 contained about 0.03 per cent oxygen.

FOREIGN LITERATURE

Defects in Brass Plating — Influence of Bath Temperature

E. R. Thews: *Galvanotechnik*, **47**, No. 7, 300.

With increasing bath temperatures, cathodic polarization is reduced and the copper in the deposit is increased correspondingly; the current efficiency also rises. With increasing temperatures, the deposit generally becomes softer and more ductile and is easier to buff. The danger of blistering and lifting during the after-treatment stages is reduced. The brass deposits assume a darker and more matte appearance.

Favorable temperature ranges are 20° to 22°C. on the one hand and 35° to 50°C. on the other but, under certain conditions, optimum results can also be obtained in the intermediate range. Bath temperatures which are too high will result red brass deposits; temperatures which are too low will give blistered deposits and poor throwing power. If the bath compositions are carefully controlled and the fairly narrow temperature ranges indicated above are used, any marked trouble is not likely to be encountered. However, unless a suitable temperature range is adhered to, significant changes will be encountered in the composition of the deposit and, consequently, in the appearance. If color changes in the brass deposit are encountered, although the temperature has varied only to a small extent, it can be caused either by variations in the voltage, current density, bath composition.

With increasing current density, the copper content of the brass plate is reduced and its color becomes lighter. Under normal working conditions and with correct bath temperature, with a current density of 0.3 amp./dm.^{2}, a warm to gold-like color tone will be obtained. Above this figure, the brass plate will become lighter in tone. Various disadvantages are encountered with increase in current density and, for color control, it is easier and more advisable to operate this by temperature control with a steady current density.

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FLEXIBLE POLISHING...Where both fast cut and a smooth finish are wanted, **Grade "E" Lea Compound** is used for flexible polishing of hard chrome plate. Sewed muslin, felt wheels, or loose buffs can be used, depending upon the amount of abrasion desired. Where heavy cutting is required, **Ad-Lea-Sive** is ordinarily used as a sizing on the sewed buffs or felt wheels. When small defects, burns, etc. are to be removed and the surface brought to a uniform finish, use a flexible polishing operation with **Grade "C"** or **Grade "B-31" Lea Compound** on sewed buffs or loose muslin buffs.

SATIN FINISHING...This is a final finish for hard chrome plate, produced at a speed of 5000 sfm. Use **Grade "N" Lea Compound** on loose muslin buffs or on **Lea String Wheels.** Finer and coarser grades of **Lea Compound** are available.

BRIGHT FINISHING...To produce this finish, showing no surface defects, use **Grade 305-A** or **304-B Learok** (bar compositions) or **Lea Liquabrade Grade 7370** (liquid composition) with the same buffs and wheel speed as for satin finishing.

BUTLER FINISHING...This finish can be obtained with **Grade "FG" Lea Compound** on a packed loose muslin buff at 5000 sfm following the bright finishing operation.

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SHOP PROBLEMS

METAL FINISHING publishes, each month, a portion of the inquiries answered as a service to subscribers. If any reader disagrees with the answers or knows of better or more information on the problem discussed, the information will be gladly received and the sender's name will be kept confidential, if desired.

Hard-Coat Anodizing

Question: In your February 1961 METAL FINISHING you published an article by Irving Machlin and Neal J. Whitney entitled "Anodizing Aluminum Alloys Evaluation of Thick (Hard) Coatings." There was mention made of a method by which a hard coating could be applied to aluminum in up to 0.010". Any information on how to produce this coating would be greatly appreciated.

We have been running tests on a 15% sulphuric acid solution saturated with carbon dioxide and held at 20°F., voltage 15, and current up to 25 amp./sq.ft. for 60 minutes. Under these conditions we are only able to obtain thicknesses of 0.002".

I would appreciate any other information you could send me along these lines.

D. S.

Answer: In order to produce oxide thickness up to 0.010" it is necessary to anodize at a much higher voltage than you are using. Voltages up to 60-70 are employed, controlled so that a constant current density is applied at about 35 amp./sq.ft.

Your present rate of 0.002" in one hour is normal, and the time will have to be increased for the thicker coating. Superimposition of alternating current at 40 volts will permit use of higher current densities as the deposit thickens.

Plating Baby Shoes

Question: I have been doing a little acid copper plating but I am lost as to what voltage, amps, and time for plating. I have one book giving 2 volts, 5 amps, 6 hours for baby shoes. Is this right? I cannot find the plating time for acid copper in my Guidebook. My rectifier is 6 volts, 100 amperes with a control. Any information you would give me would surely be appreciated.

E. P. H.

Answer: There is no such thing as a standard plating time for any metal. The time required will depend on the amperage employed and the requirements of the job. The amperage, in turn, will depend on the shape of the part, distance from the anodes, solution composition, temperature, agitation, and amount of dirt in the bath.

For baby shoes, it is necessary to apply sufficient copper so that the shoe will not deflect when light pressure is applied. Use the maximum voltage and amperage which does not result in a spongy deposit on edges. The shoes can be removed from the solution and examined at intervals.

Brass Colored Deposit

Question: Will you please identify the finishing system on the enclosed sample. There is a possibility that it is not just a burnished brass plate over steel with subsequent lacquering. My customer wonders if it is a finish over zinc or cadmium, or perhaps even a colored organic finish.

Is it possible for you to determine the type of lacquer, whether it is a bake or air dry type?

M. S.

Answer: The sample forwarded appears to have a fairly good brass plate over a steel base. The lacquer coating dissolves in acetone, which would indicate an air-dry type, although this is not an absolute test.

Producing Porous Deposits

Question: We are interested in electroplating a high purity copper from either acid or cyanide copper plating baths. We prefer a deposit which is spongy or porous, one that has a density of about 90 per cent. This is actually a buildup of copper deposit on a cylinder where the deposit will be in the order of 8 mm on the radius.

We do not know if this is feasible and, therefore, would like information concerning any possibilities. It was though that perhaps you might have papers written on this subject for METAL FINISHING. However, if you do not have any information concerning this electrodeposition, would you please direct us to some source where we could obtain this information.

C. J. B.

Answer: A paper was presented by C. L. Faust and W. H. Safranek (Trans. Inst. Metal Finishing, 31, 517 [1954]) describing a method of producing porosities above 50% by the addition of colloidal graphite suspensions to the plating solution.

Cobalt Plating

Question: I am writing to ask your kind assistance in securing data on the bath formulations and operating conditions of a straight cobalt plating bath. I am under the impression that cobalt sulfate is used in the make-up of this bath, but I can find no literature pertaining to the subject. The cobalt sulfamate bath with which I am familiar will not serve my purpose. Any sources of information you can pass along to me will be very much appreciated.

M. S.

Answer: The standard sulfate bath composition is as follows:

Cobalt sulfate	68 oz./gal.
Sodium chloride	2.3 "
Boric acid	6.0 "
Temperature	Room
pH	3-5
Current density	30-160 amp./sq. ft.

Cast or rolled cobalt anodes

Further information on the baths will be found in the Transactions of The American Electrochemical Society, **27**, 1-43 (1915).

F.A.C.T. Test

Question: We understand that there is a new test for anodized aluminum, called the F.A.C.T. procedure. Any information you can supply us on this

test would be sincerely appreciated.

E. S.

Answer: This test is an electrolytic modification of the CASS test (copper-modified acetic salt spray) and was developed for automotive evaluation of anodizing. It shows a direct correlation between sealing temperature and corrosion resistance of the oxide film. It is based on the application of current on the surface of the sample, the electrical resistance of which measures the corrosion-protective value of the anodic film. Results are obtained in about 3 minutes, using a current of about 0.8 milliampere and measuring the voltage required. The test has been made more meaningful by converting the instantaneous voltage to frequency, which is measured with a frequency counter.

Yellowing of Barrel Nickel Plate

Question: We would like to know what causes bright barrel nickel plated steel parts to turn yellow after standing for a day or two. The yellow coating is removed in an acid dip.

R. K.

Answer: The yellowing of barrel nickel plated steel parts after a day or two usually indicates that the deposit is very thin and porous, and that the steel base is beginning to rust out. This can be confirmed by a porosity test, or an accelerated corrosion test such as the salt spray or hot water test.

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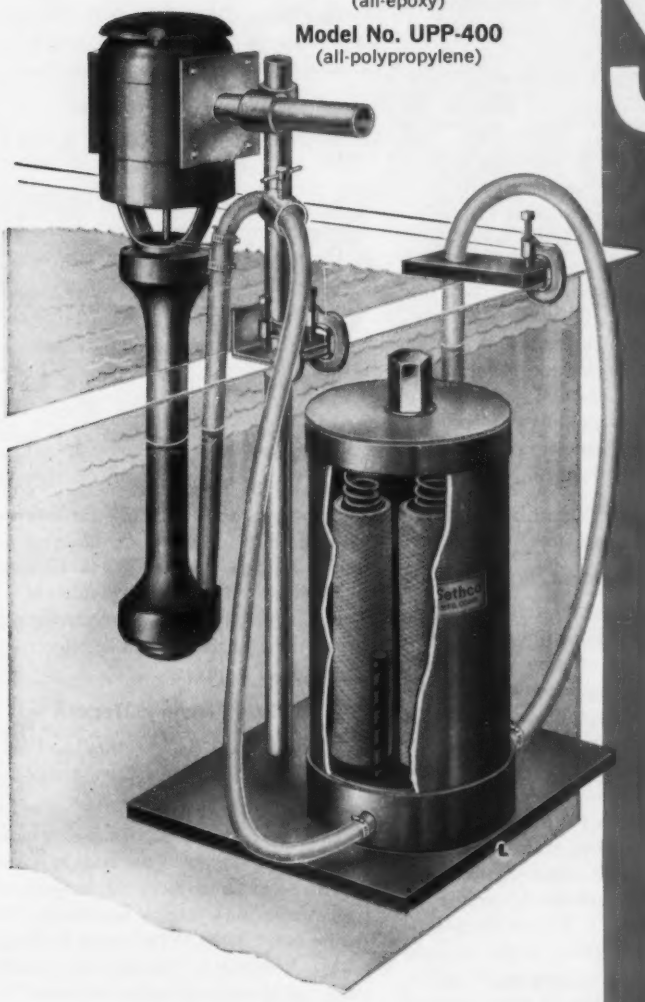

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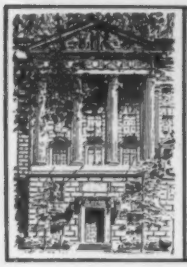

Patents

RECENTLY GRANTED PATENTS IN THE METAL FINISHING FIELD

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Conversion Coating — Zinc

U. S. Patent 2,977,259. *Mar.* 28, 1961. *L. E. Schmelzer, assignor to U. S. Steel Corp.*

A method of treating galvanized articles to inhibit white rust formation, which comprises immersing the articles in a dilute water solution containing from 0.1 to 0.5% of a dichromate selected from the group consisting of sodium, potassium or ammonium dichromate and then in a dilute water solution containing from 0.1 to 0.6% of a fluoborate selected from the group consisting of sodium and potassium fluoborates, and from 0.1 to 0.4% of one of said dichromates, said last-mentioned solution having a pH of from 4 to 6.

Conversion Coating — Aluminum

U. S. Patent 2,977,260. *Mar.* 28, 1961. *G. J. Biefer and F. H. Krenz, assignors to Atomic Energy of Canada Ltd.*

The process for inhibiting the corrosion of an Al-Ni alloy containing from 0.5-5% Ni which is in contact with an aqueous system at from 150° to 350°C., wherein the alloy is contacted, at said temperature, with a solution consisting essentially of silicic acid in substantially deionized water, the silicic acid being present in an amount varying between 100 p.p.m. up to that amount which produces saturation at the temperature of operation, the silicic acid solution having a pH of not substantially less than 5.0.

Thick Anodic Coatings on Aluminum

U. S. Patent 2,977,294. *Mar.* 28, 1961. *J. B. Franklin, assignor to Sanford Process Co., Inc.*

A process for coating aluminum articles with a hard and dense coating of oxide of aluminum which comprises passing an electric current at increasing voltage through an electrolytic cell containing an electrolyte with said article forming the anode, said electrolyte comprising a water solution of sulfuric acid having an acid concentration equivalent to between about 16 and 20% by volume of solution of 66 Baumé sulfuric acid and an oxide coating accelerator as additive, until an oxide coating of at least about .0005" and not greater than .003" thick is formed and continuing to electrolytically oxidize said article at increasing voltage in an electrolyte comprising a water solution of sulfuric acid having an acid concentration equivalent to between about 7 and 12% by volume of solution of 66 Baumé sulfuric acid and an oxide coating accelerator as additive, until a desired increase in oxide coating thickness substantially greater than the coating thickness produced in said first electrolyte is formed.

Zinc Bath for Aluminum & Magnesium

U. S. Patent 2,977,295. *Mar.* 28, 1961. *C. F. Cooper*

An aqueous composition suitable for the electroplating of zinc on a metal selected from the group consisting of aluminum, steel and magnesium, said composition comprising essentially in solution at least about 10 grams of zinc per liter and at least about 10 grams of titanium per liter, the principal negative ions of said solution being fluoborate ions; said solution being maintained sufficiently acidic so that it manifests a yellow to yellow brown color as opposed to the emerald green color of solutions more acidic and the brown color of solutions less acidic.

Ultrasonic Degreaser

U. S. Patent 2,977,962. *April* 4, 1961. *J. Zucker*

Apparatus for the cleaning of metal particles comprising a container adapted to receive a cleaning liquid, means in the base of said container for producing supersonic waves in said liquid, said container having a circulating conduit connected thereto, said conduit including a circulating pump, a filter and a hermetically sealed degasification vessel, said vessel being disposed at an elevated position compared with said cleaning container, the difference in level corresponding to the vapor pressure of said cleaning liquid.

Vapor Phase Corrosion Inhibitor

U. S. Patent 2,978,293. *April* 4, 1961. *L. Cerveny*

A method of protecting a metal surface against corrosion, comprising contacting the metal surface with the neutral chromic acid ester of tert-butyl alcohol in the vapor state.

Mist and Paint Saver

U. S. Patent 2,978,186. *April* 4, 1961. *P. Mayerchak*

An accessory of the usual oppositely tapered form for removable attachment to the nozzle of a pressure type spray gun mounted upon a liquid supply container to be manually supported.

Copper Stripper

U. S. Patent 2,978,301. *April* 4, 1961. *P. H. Margulies and J. E. Kressbach, assignors to Food Machinery and Chemical Corp.*

Method of dissolving metallic copper, comprising contacting the copper with an aqueous solution containing as solutes therein, about 10% to 45% of a persulfate and a catalytic amount of ions of a metal having an electrode potential more negative than the electrode potential of copper.

Paint Recovery Method

U. S. Patent 2,978,344. *April* 4, 1961. *J. Parker and W. N. Knutsen, assignors to Illinois Tool Works*

The method of recovering excess paint spray material having metallic particles in a water-soluble carrier whose solubility varies inversely with temperature so as to gel upon heating, which comprises mixing the excess paint spray material with cool water to form a slurry, heating the slurry to gel said carrier, removing excess water from the slurry, and then cooling the slurry to dissolve said carrier.

Hot Dip Coating Method

U. S. Patent 2,978,355. *April* 4, 1961. *A. Busch*

The process of metalizing a metal strip, including steel strip, by means of hot dipping; comprising the steps of preheating said strip, contacting said strip with flux means, passing said strip through a bath of metallic melt,

then feeding said strip between squeezing rollers at a location out of contact with said melt and in the presence of an inert protective gaseous medium, to rid said strip of surplus metal, and simultaneously supplying to the strip surfaces predetermined small quantities of a reducing and lubricating agent, respectively.

Metal Silicate Coating

U. S. Patent 2,978,361. *April* 4, 1961. *A. Seidl, assignor to Deutsche Gold-und Silber-Scheideanstalt vormals Roessler*

A process for the surface treatment of metals which comprises applying a coating of an alkaline aqueous solution of an alkali metal silicate in which the proportion of alkali metal oxide to silicon dioxide is 1:2.5 to 1:5 and 0.05% to 2%, based upon the weight of the alkali metal silicate, of at least one heavy metal in the form of an alkali stable and water soluble compound over the metal surface to produce a non-crystalline silicate containing coating, drying the coating and heating the coating to a temperature between 100 and 400°C.

Electroforming

U. S. Patent 2,978,389. *April* 4, 1961. *A. A. Turnbull, assignor to North American Philips Co., Inc.*

A method of manufacturing a metallic screen structure comprising a taut metallic screen member and a rigid frame member having an opening, said screen member being stretched taut over said opening and secured at positions around said opening to said frame member comprising the steps, placing said screen in a slack condition over said opening, securing said screen to said frame member at points positioned around said opening, electroplating said thus mounted screen in an electro-deposition bath with an amount of a metal under a state of tensile stress sufficient to cause said screen to be stretched taut over said opening.

Acid Gold Bath

U. S. Patent 2,978,390. *April* 4, 1961. *A. R. Atwater and E. M. Julich, assignors to Bell Telephone Laboratories Inc.*

A gold plating bath consisting of a solution made up by mixing sodium gold cyanide, distilled water, and a member selected from the group consisting of phosphoric and fluoboric acids, said bath having a pH value of 1.8.

Bright Nickel Bath

U. S. Patent 2,978,391. *April* 4, 1961. *A. H. Du Rose, assignor to The Harshaw Chemical Co.*

A nickel electroplating bath comprising an aqueous solution of a nickel electrolyte selected from the group consisting of nickel sulfate, nickel chloride, and mixtures thereof, said solution also containing cooperating brightening addition agents, one of said brightening addition agents being at least one organic compound selected from the group consisting of aromatic and unsaturated aliphatic sulfonates, sulfonamides and sulfimides and the second of said brightening addition agents being a compound of the formula $A—S—(CH_2)_nCN$, wherein n is an integer from 1 to 4 and A is selected from radicals of the class consisting of:

$NC(CH_2)_n$; $NC(CH_2)_nS(CH_2)_m$

m being an integer from 1 to 4; alkyl, 1 to 4 carbon atoms; alkenyl, 1 to 4 carbon atoms; alkynyl, 1 to 4 carbon atoms; $R_2NC_nH_{2m}$, where R is chosen from alkyl, alkenyl and alkynyl radicals of from 1 to 4 carbon atoms;

$$R_2N—\underset{|}{C}=N—R$$

where R is independently chosen from alkyl, alkenyl, and alkynyl radicals of from 1 to 4 carbon atoms; and compounds corresponding to the foregoing compounds wherein OCH_2CH_2 has been substituted for $(CH_2)_2$, the first said brightening addition agent being present in said solution to the extent of from 0.05 to 20 grams per liter and the second said brightening addition agent being present in said solution to the extent of from 0.0001 to 0.015 gram per liter.

Polyelectrolyte Baths

U. S. Patent 2,978,394. *April* 4, 1961. *S. P. Moyer, assignor to American Cyanamid Co.*

A process for electrodeposition of metals from commercial aqueous systems in the electrowinning of ores and the electroplating of metals which comprises sequentially: introducing from 1 to 1,000 parts per million parts of the electrolyte by weight of a water-soluble polyelectrolyte selected from the group consisting of acrylamide homopolymers and acrylamide copolymers containing at least half of the monomer units of acrylamide and the other half selected from monomer units containing an aliphatic olefinic unsaturated linkage, then filtering non-dissolvable finely divided impurities from the electrolyte, and then electrolyzing to recover the metal from the electrolyte.

Corrosion Preventive

U. S. Patent 2,978,423. *April* 4, 1961. *R. Tirtiaux and J. B. Signouret, assignors to Esso Standard Societe Anonyme Francaise*

A rust inhibiting composition consisting essentially of oil, about 0.1 to 10.0 wt. per cent of a polymeric material consisting of an alkoxylated alkyl phenolformaldehyde copolymer and about 0.05 to 5.0 wt. per cent of an oil soluble material selected from the group consisting of alkali metal sulfonates of 12 to 25 carbon atoms and alkali metal naphthenates of 8 to 18 carbon atoms, and wherein said alkoxylated alkyl phenols contains about one to four C_2 to C_6 alkylene oxy groups per molecule and about one to two C_6 to C_{20} alkyl groups per molecule.

Flexible Abrasive Wheel

U. S. Patent 2,978,845. *April* 11, 1961. *E. S. Haven and R. A. Brooks, assignors to Norton Co.*

An annular abrasive wheel comprising a plurality of abrasive coated sheets, said sheets being secured in an annular row, each side of said wheel being provided with at least one annular groove having a reinforcing ring positioned therein, at least one annular groove in the internal periphery of said wheel, said groove being narrowest at its inner diameter and widest at its outer diameter, and a reinforcing member positioned in said groove, said reinforcing member conforming to the shape of said groove.

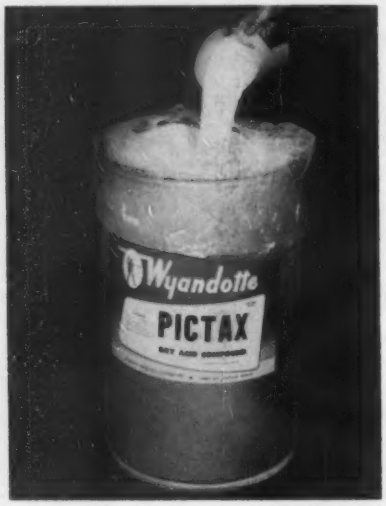
Barrel Finishing Media

U. S. Patent 2,978,850. *April* 11, 1961. *K. M. Gleszer, assignor to Dixon Sintaloy, Inc.*

An improved process for finishing the surfaces of work pieces which comprises, tumbling the work pieces in a medium of pellets, said pellets made of sintered powdered metal and formed with regular file-like surface serrations thereon.

Acid Pickling Salt

Wyandotte Chemicals Corp., J. B. Ford Div., Dept. MF, Wyandotte, Mich.



For use on steel, zinc die castings, copper and brass, Pictax removes stains, rust and scale, provides high activation of metal surfaces, improves adhesion and brilliance of plate. It is claimed to remove rust, scale, and smut from steel, chromium plate from rejects, and activates nickel before chromium plating. It also is excellent for preparing zinc die castings, brass, and copper for plating.

According to the manufacturer, the salt features high resistance both to organic and inorganic contamination, and eliminates changing the acid dip in the middle of the week, or even on a weekly basis.

A completely soluble, granular, dry acid, the product does not fume, rinses freely, is safe to handle, easy to control and convenient to use. Designed to replace sulfuric, hydrochloric, and other strong liquid acids used in pickling operations, the salt is available in 375-pound, non-returnable fiber drums for easy handling and storage.

Soak Cleaner

Enthone, Inc., Dept. MF, 442 Elm St., New Haven 8, Conn.

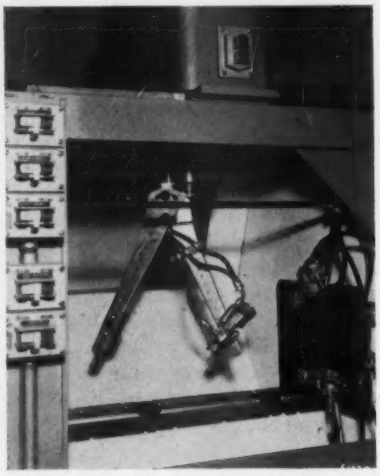
An alkaline soak cleaner which does not contain silicates, but yet does not appreciably etch aluminum, Aluminum Cleaner NS-35 removes light soil, marking inks, and light buffing compounds. It is a powdered material which is dissolved in water at 2-8 oz./gal. concentration. At operating temperatures below 150°F. it does not etch aluminum, while above 150°F. very mild, controlled etching can be accomplished. It has good detergency in both temperature ranges.

The cleaner is also effective as a soak cleaner for zinc die castings and other reactive metals.

Rotating Spray Gun

Finish Engineering Co., Inc., Dept. MF, 921 Greengarden Road, Erie, Pa.

A high-speed rotating spray gun assembly is claimed to make practicable production rates up to ten times previously possible. The new mechanism,



called Roto-Matic Coater, reaches speeds up to ten times the previous normal operating rate of 50-75 r.p.m. The coater produces painted parts at a rate of 10-inches per second when used on the Ride-the-Rod machine.

The new gun can be used with almost any type of spray coating, including epoxies, varnishes, and others.

Platinum-Plated Titanium Anodes

Technic, Inc., Dept. MF, P.O. Box 965, Providence, R. I.

Called Platanodes, these anodes, heavily plated with platinum, may be substituted for solid platinum in rhodium, acid gold, platinum, palladium, and rhenium plating solutions.

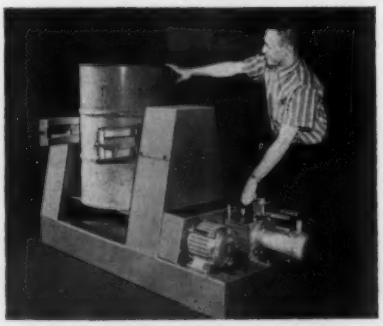
The anodes make it possible to use enough anode surface area to provide optimum throwing power for many solutions at a reasonable cost. They are virtually indestructible, won't curl, bend, or flex, and are as strong as steel, it is stated.

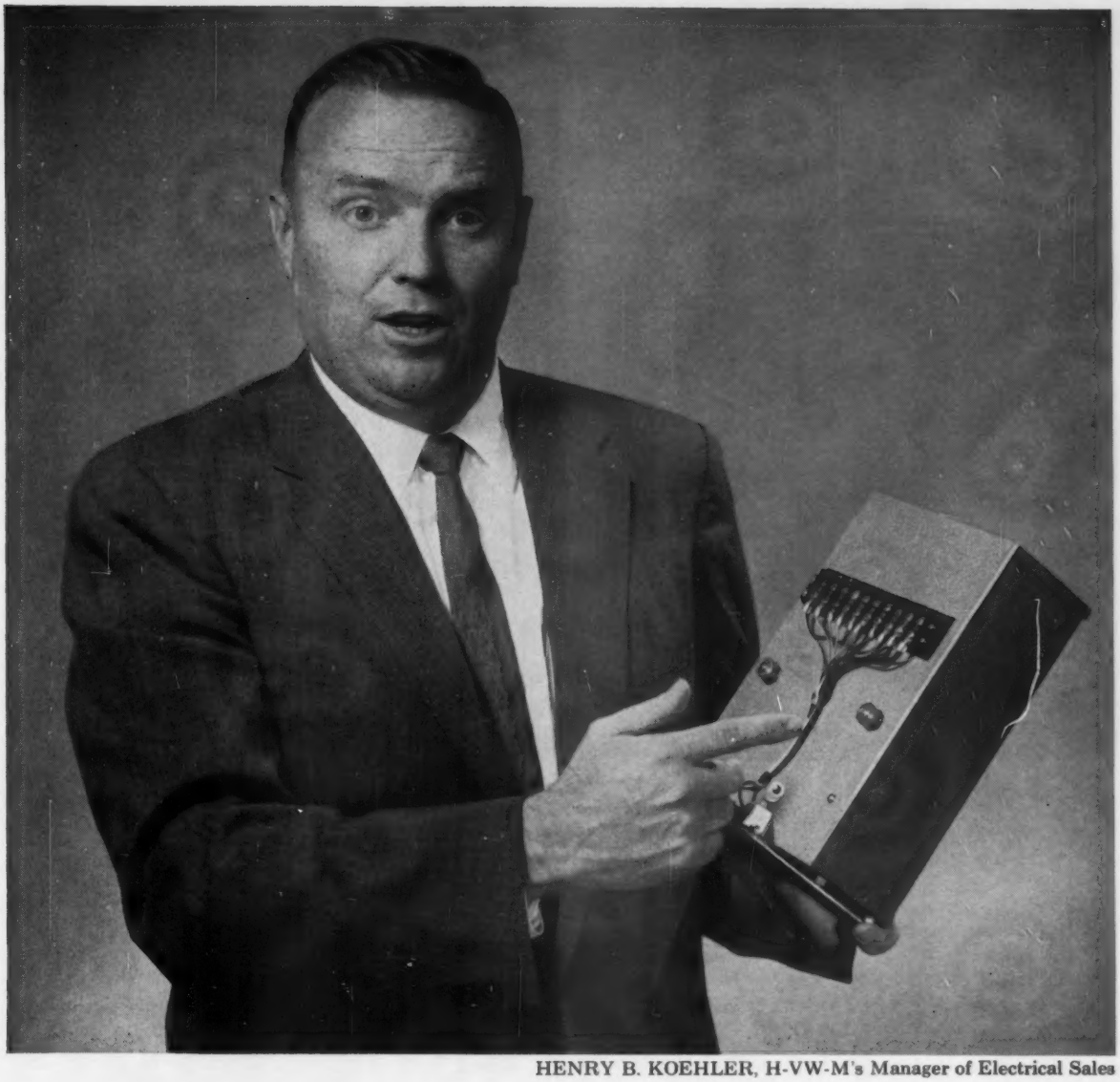
The heavy platinum electroplate is bonded firmly and directly to the titanium base. Standard sizes are 3 inches wide in any length with 1 by 3½-inch tail. Any shape or size is available on special order.

Drum Tumbler

U. S. Stoneware Co., Dept. MF, Akron 9, Ohio.

Drum tumblers with built-in hydraulic lifts for raising 55-gallon steel drums to proper height for clamping into position on the tumbler, are a special modification of the manufacturer's standard line of Fig. 730 drum tumblers, and incorporate the additional feature of a loading platform which can be raised and lowered under control from a 3-way hydraulic valve. The drum to be clamped into the tumbler is placed on the platform, inside the holding clamps, which are in open position as shown in the photo. The platform is then raised under power from a separate motor which operates the hydraulic system. When drum has reached the proper level for clamping, the clamps are closed and locked around the drum. The hydraulic-lift platform is then lowered, and





HENRY B. KOEHLER, H-VW-M's Manager of Electrical Sales

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A package of good news for platers!

It's the new *control package* from H-VW-M . . . and here's what it offers you:

Less Downtime, Fewer Rejects. Automatic current limiting is standard, not an extra. Unit won't shut down on normal overloads and shorts.

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AVS or ACC. (automatic voltage stabilization, automatic current control) . . . with current limiting . . . are both available at flick of selector switch.

Also yours with this new package control: the advantages of smaller size, less weight, no moving parts. *And the price is hundreds less than you'd pay for the same features in separate rectifier units of conventional design.*

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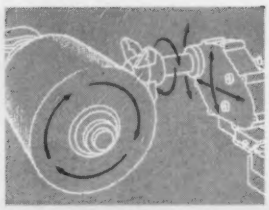

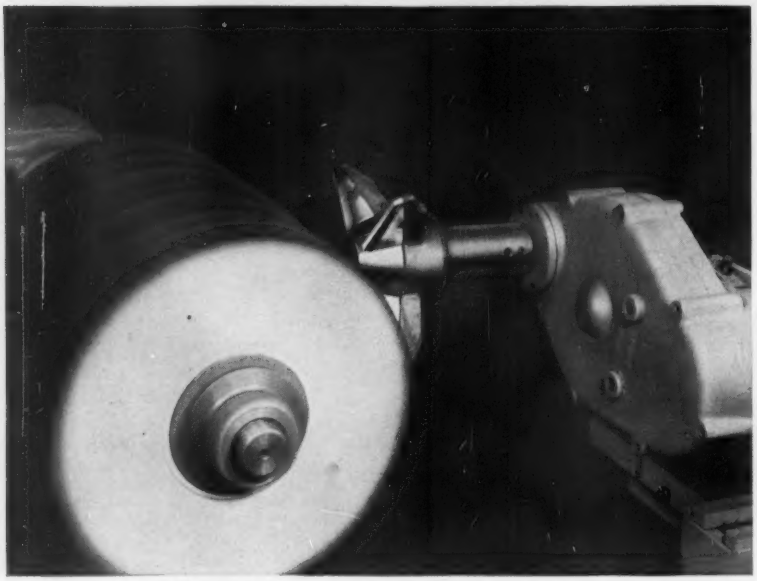

Doing more work with *Movement and Motion*

The die-cast part being "mush" buffed above happens to be an automotive accessory having recessed, contoured surfaces. But it could be almost any other type of limited production part presenting similar finishing problems because the equipment performing the operation is a versatile Acme Semi-Automatic Polishing and Buffing Machine. Note that the ruggedly built work holding unit has an adjustable horizontal stroke that distributes wear evenly across the buffing wheel. Note, too, that the exclusive Acme oscillating head attachment simultaneously rotates the part and moves it vertically above and below the center line of the wheel to assure maximum coverage, greater uniformity of finish. Matter of fact, this unique combination of movements and motions—this added Acme action—does so much more work so much better that two operations can often be combined into one!

Want complete information about this and other Acme semi-automatic finishing equipment? A catalog is yours for the asking.

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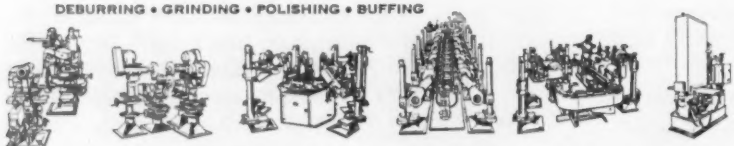

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Leading Producers of Automatic Polishing, Buffing and Deburring Machines Since 1910

the drum is rotated by the main tumbler motor.

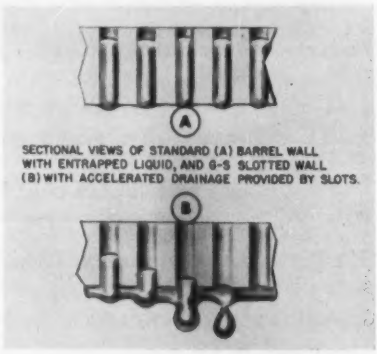
Special advantages of the hydraulic-lift tumblers are the reduced danger of physical injury to workmen when heavy drums are loaded manually, and the greater speed of drum loading. Use of hydraulic-lift drum tumblers also eliminate from the tumbler loading operation the need for lift-type trucks and overhead hoists.

The hydraulic lifts are available on both single or double-drum tumbler models. Optional drives for both the tumbler and the integral hydraulic lift may be constant or variable speed, and explosion-proof, for operating in volatile atmospheres. Many optional controls are available including electric brakes, clocks, revolution counters and special timing devices.

Improved Drainage Plating Barrel

G-S Equipment Co., Dept. MF, 15583 Brookpark Road, Cleveland, Ohio.

A new wall design for plating barrels has small perforations, which greatly reduce "transfer" contamination. Continuous parallel slots, cut across the outside openings of the wall perforations, create "cohesive capillary" action that pulls liquids from these holes in a highly accelerated drainage action, it is claimed. This is shown in the diagrammatic illustrations — where, in "A", the natural cohesion of small amounts of liquids holds them in the perforated tubes, while, in "B", the cohesion and added



SECTIONAL VIEWS OF STANDARD (A) BARREL WALL WITH ENTRAPPED LIQUID, AND G-S SLOTTED WALL (B) WITH ACCELERATED DRAINAGE PROVIDED BY SLOTS.

weight of liquids in the slots act to pull the entrapped liquids from the tubes.

Polypropylene Anode Bags

M. E. Baker Co., Dept. MF, 25 Wheeler St., Cambridge, Mass.

These new polypropylene anode bags are highly recommended for use in both acid and alkali solutions and may

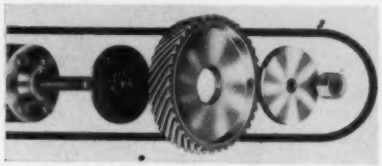
be used in service up to 280°F.

Polypropylene has low moisture absorption and, because of its waxy nature, the fiber will not retain any sludge, dirt, or even dyes. The bags can be washed and reused in the same bath or in different baths over and over again.

Wet or dry these bags have unusual strength. These bags are stocked for immediate shipment.

Contact Wheels

Cosmo-Wheels, Inc., Dept. MF, 1019 Fulton St., Chicago 7, Ill.



The new Cosmo-Contact wheels have self-aligning flanges, designed for use with present equipment, which is claimed to reduce grinding and finishing cost, because of reduced vibration. These flanges are ruggedly constructed of ⅛-inch steel discs, faced with a rubber cushion that fits up snug on any worn or scored shaft. Centrifugal force will give perfect alignment, a balanced, vibration-free operation, and eliminate high and low spot problems.

Electrocleaner

Magnus Chemical Co., Inc., Dept. MF, Garwood, N. J.

A new electrocleaning chemical, 24-Y, is designed for both anodic (reverse current) and cathodic (direct current) cleaning of steel, iron, stainless steel and copper prior to electroplating.

The new cleaner, according to the manufacturer, provides the fastest, most effective cleaning possible through its very high electrical conductivity. It also contains agents to provide excellent rinsability and to emulsify and prevent redeposition of oils. In addition, it provides longer bath life than electrocleaners formerly available, it is claimed.

The material is used in a mixture of eight to 12 oz./gal. of water at temperatures ranging from 190° to 200°F. for either anodic or cathodic cleaning. Depending upon the current output of the electrical system, 40 to 100 amp./sq. ft. are used. Cleaning time varies from 30 seconds to three

To Keller Manufacturing Co., Inc., it means a savings of nearly $50 a day in finishing costs on leaf rakes. And, theirs is a comparatively small plant operation.

Before moving into their new plant, this St. Louis manufacturer of Sweep-Easy lawn and garden tools investigated and tried out various finishing equipment. They chose Ransburg No. 2 Process to do the job because they found that only the Ransburg Electrostatic Hand Gun could give them the desirable increase in production—with improved quality—and at lower cost.

PRODUCTION IS NEARLY DOUBLED
QUALITY OF FINISH IS IMPROVED

With the Ransburg Hand Gun, Keller's daily painting prodution of leaf rakes nearly doubled what they were formerly getting with air hand spray. And, where they used to get only 168 rakes per gallon of paint, they now get 426 per gallon—over 2½ times as many—actually *an increase of over* 150% *in paint mileage.* With the unique "wrap-around" feature, electrostatic is improving the quality, providing a complete, uniform coating over all areas—even on the tine edges.

NO REASON WHY YOU CAN'T DO IT, TOO!

See how the Ransburg Electrostatic Hand Gun can save time . . . paint . . . and cut costs in YOUR finishing department. Or, if your production justifies, it'll pay you to investigate Ransburg's automatic electrostatic spray painting equipment. Write for our No. 2 Process brochure which shows numerous examples of modern production painting in both large and small plants.

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RANSBURG Electro-Coating Corp.

Box 23122, Indianapolis 23, Indiana

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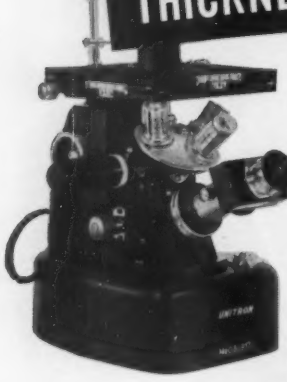
WHY GUESS ?

MEASURE PLATING THICKNESS



to a millionth of an inch

Your profits depend on meeting tight specifications, maintaining quality control and reducing rejects. Can you afford to guess at plating thickness when it is so easy to *measure and be sure*?

UNITRON'S PL-MEC PLATER'S MICROSCOPE substitutes facts for uncertainty. The plated deposit is observed through a Filar Micrometer Eyepiece and measurements are read directly from a micrometer drum. This compact microscope is easy to use, portable around the shop and has a built-in light source. It also doubles as a metallurgical microscope for examining grain structure etc. at magnifications of 25X-1500X. Permanent photographic records may be made using an accessory 35mm. camera attachment and provide valuable legal protection for subcontractors.

UNITRON'S PLATER'S MICROSCOPE will save its initial cost many times over. Prove this for yourself — as so many firms in the plating industry have done—by requesting a **FREE 10 DAY TRIAL** in your own plant. There is no cost and no obligation.

Above: Accessory camera attachment.
Left: Observing the plated deposit.

$468 Model PL-MEC complete with all optics and standard accessories	As above with built-in camera attachment, but without 35mm. camera back: **$540**

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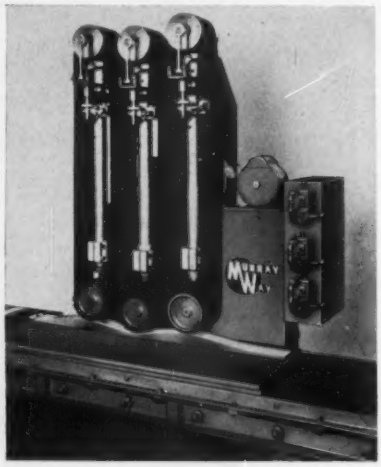
minutes, depending upon soil, current density and cycle requirements.

The product is offered by the company on a 30 day trial basis. A drum may be tested, following instructions and, if performance is not entirely satisfactory, the unused material may be returned for full cancellation of the invoice.

Belt Polisher

Murray-Way Corp., Dept. MF, Box 180, Birmingham, Mich.



Flat, formed, or contoured parts, both long and short, can now be polished wet or dry, from roughing to finishing in one pass by the new Multiple-Float abrasive belt heads. Each head floats independently of the others, but one motor will drive up to three heads at once. The rise and fall of each head may be controlled by the contour of the part itself (where polishing is the principal function), or by a cam shaped to the production part (where shaping or closer tolerance grinding is required). Friction-free lineal ball bushings, mounted on hardened rods and boot-protected from dirt, support the rise and fall of the heads.

Any continuous travel or reciprocating conveyors may be utilized for traversing the parts beneath the heads. Belt tracking and oscillation are controlled by the exclusive "Air-Eye," which automatically prevents belt run-offs. Oscillation of idler rolls is supported on angular thrust bearings for friction-free pivoting, and pivot assembly is boot-protected from dirt.

Abrasive belt tension is maintained by a built-in air cylinder, and hand-operated valves allow release for quick belt changes. The standard machine is equipped with 5″ wide by 90″ long belts, but the tubular support for the idler roll may be lengthened or shortened to accept belts of other lengths. Air controls are mounted in a closed panel.

Polishing Composition

American Buff Co., Dept. MF, 2414 S. La Salle St., Chicago 16, Ill.

Ideal for zinc die-cast, aluminum, brass and copper, BT-8 bar compound imparts a high luster, provides fast cutting and is easily cleaned. Easy to work, it may be used in automatic or manual operations.

In on-the-line tests, the material clings well, provides a good head, and has a firm, high tensile strength. It gives better finishing with fewer passes, longer buff life and savings in time and labor, it is claimed.

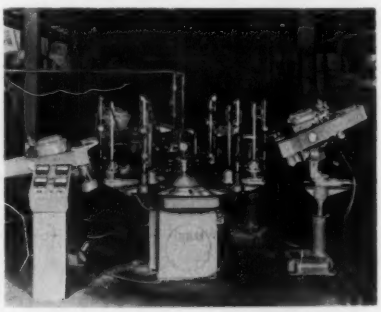
The product comes in bar form, in 25-pound and 100-pound cartons. It is also available in drums.

Contour Polishing Machine

Divine Bros. Co., Dept. MF, Seward Ave., Utica 1, N. Y.

Model RJ4X is a new rotary automatic contour polishing machine, capable of finishing as many as 1,000 small metal parts or tools per hour. The machine can also be modified for high-speed polishing of flat surfaces, as well as contours.

The unit is basically comprised of a special indexing type rotary dial conveyor and four DLS contour abrasive belt head units. The conveyor has six hydraulically-driven fixture spindles, four working and two at loading and unloading stations. The head units feature air control of both belt tension

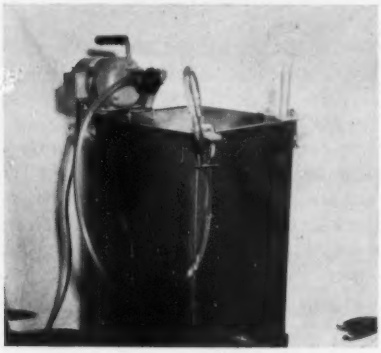


and the contact wheel. Work is carried from the loading station to each abrasive head, in turn, and automatically positioned for the various finishing operations performed at each station.

Solution Filter

Mahoney Associates, Dept. MF, 87 Weybosset St., Providence, R. I.

"Filter Lyte" is a cartridge-type filter, with components designed for maximum efficiency and long life under the highly corrosive conditions encountered in plating solutions. The core of the new filter is of perforated high-temperature Lucite. It is surrounded by "cogs" of Feutron, a specially designed synthetic fiber felt manufactured to closely controlled specifications for maximum stability and filtering characteristics.



The filters are being manufactured in two-gallon and 5.2 gallon-per-minute capacities. The cartridges are available in standard 8 and 4 inch lengths and can be used in any applications where re-cycling filtration is required.

Positive filtration occurs through the five micron filter on the suction side of the pump. The system takes the discharge of the pump and uses it to agitate the plating solution. In addition, the unit has a skimming device of high temperature Lucite, in which the high density cartridge is inserted to remove impurities from the tank's top. Other features of the system are:

The cartridge can be changed in one minute or less with no loss of solution.

The cartridge has 143 sq. in. of surface filtering area.

The unit is easily carried and moved, and is self-priming.

Zinc and Cadmium Bath Purifier

Conversion Chemical Corp., Dept. MF, Rockville, Conn.

Kenvert Metal Purifier Concentrate finds special application in cadmium plating solutions to prevent burning in high current density areas. It ties up the usual heavy metal contaminates, with the exception of copper. Use of this product greatly reduces the amount of brightener required, it is claimed. Distinct improvement has been achieved in many applications with as little as 4 fluid ounces per one hundred gallons.

The product also acts as a scavenger in zinc baths and helps to intensify the action of proprietary brighteners. It is shipped in 5 gallon pails.

Pickling Additive

Frederick Gumm Chem. Co., Inc., Dept. MF, 538 Forest St., Kearny, N. J.

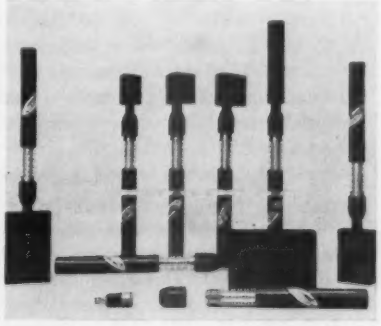
An addition agent for acid solutions, Clepo Pickle Aid E-2 completely suspends any oil globules present in acid solutions, thereby preventing them from re-depositing on parts prior to plating operations. In addition, it provides a uniform foam blanket on the top of pickling solutions and eliminates the presence of obnoxious acid fumes. The product can be used in pre-plating acid dips and will not interfere with subsequent plating operations, it is claimed.

Selective Plating Anodes

Selectrons, Ltd., Dept. MF, 520 Fifth Ave., New York 36, N. Y.

Two new types of plating styluses, half-round and flat, are now available for use with the company's selective electroplating systems.

The flat SF anode is available in three different sizes, up to 3½ x 2½ in. It is intended primarily for electroplating large flat, or slightly convex surfaces. These anodes may also be ground to a specific wedge shape, or to match a particular curvature, as for example in repairing a rotogravure cylinder.



The HR stylus, with one flat and one round surface, is particularly useful for electroplating concave cavities, such as the inside of housings, while the part rotates. It is also intended

Problem:
RUST
During Production
Answer:
magnus

"Rusting occured when parts were left overnight in our tumbling barrel. Then our Magnus Man prescribed a burnishing soap which did a better job and also licked the rust problem."
A Machinery Parts Manufacturer.

"We needed a long term indoor rust and stain preventive which would not 'cloud up' and would not dry hard. Magnafilm 120 filled the bill."
A Hardware Tool Manufacturer.

"Our rust control system was 'the best,' yet rust was wrecking our production. The Magnus Man tracked our problem to a bent float valve stem which was over-diluting the rust preventive in our spray washer."
An Auto Parts Manufacturer.

"Had been using a rust preventive after machining which required removal before painting. The Magnus Man cut costs, time and labor with an effective rust preventive which requires no removal."
A Machine Tool Manufacturer.

FREE
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Send for this new data file covering all modern methods of work-in-process rust prevention, or request a copy from your local Magnus Rust Control Specialist.

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ARMORHIDE offers you these important advantages:

- A tough, textured quality finish resembling leather, it is 10 times more abrasion resistant than wrinkle finishes and has excellent resistance to chemicals.
- ARMORHIDE can be applied to assembled metal parts and products, thus eliminating scrap, deep drawing, welding and design problems. All edges are evenly covered and free from sharpness.
- Sprayed and fused on the metal, it is applied at high solids in a thickness of 10-15 mils coating. This means rapid-action finishing at minimum cost. No expensive solvents are required.
- ARMORHIDE is free from wet sagging on a vertical finish.

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for applications involving both flat and round surfaces.

The new Type MS-5 rod-shaped anode was designed to meet the need for an anode sized between the present MS series and the larger flow-through tools used on large areas.

In-Tank Filter Systems

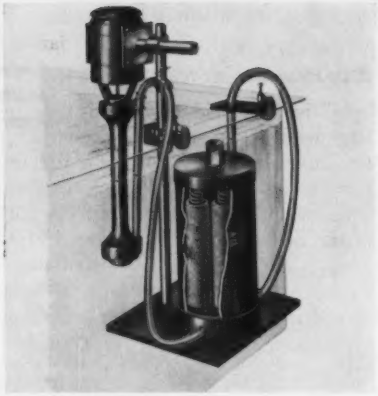
Sethco Mfg. Corp., Dept. MF, 2286 Babylon Turnpike, Merrick, L. I., N. Y.

The above firm announces that their epoxy in-tank pump is now available in a newly designed streamlined one-piece casting for the UAL and UAA series. Increased versatility is also made possible by the use of polypropylene in the construction of the detachable filter chambers and pumps for the first time and by the use of larger pumps and motors up to 1 HP.

Chromic acid can now be filtered up to 200°F. using these polypropylene filter chambers and pumps with titanium shafts. Epoxy chambers and pumps are used for filtering other solutions up to 250°F.

The UAL and UAA In-Tank filter systems are particularly useful where continuous filtrations are necessary, as in automatic plating machines, high speed plating baths and electroforming, assuring the highest quality plated product. These systems offer self priming leakproof, trouble-free operation.

Designed for filtering and agitating from 50 to 2700 gal./hr., these pumps are immersed in any non-working area of the plating tank, occupying only



5½" of the tank space. The chambers up through the 400-600 gal./hr. sizes are easily positioned in any convenient and out-of-the-way location on the outside of the tank. Larger filter chambers mounted to a linen phenolic panel occupy a minimum amount of floor space.

Besides polypropylene and epoxy in filter chambers and pumps, a variety of metallic and non-metallic shafts and fittings are available to provide chemical and heat resistance to 250°F. for all solutions including pyrophosphates, fluoborates, and high chlorides.

The in-tank pumps, now available in four sizes instead of two, are powered by ½,¾ and 1 HP, totally enclosed ball bearing motors.

Illustrated standard Model UAA-400 has a capacity of 400-600 GPH and is constructed with an epoxy pump and filter chamber with stainless steel 316 shaft and center rod with a ½ HP, 1 phase, totally enclosed, ball bearing capacitor motor.

Portable pH Meter

Sel-Rex Instruments Div., Meaker Co., Dept. MF, Nutley, N. J.

New Electrion II line-operated portable pH meters feature a ±500 millivolt scale and a unique, full-range, shock-resistant combination electrode. Standard features include: constant-reading meter; amplifier-stabilized, drift-free indicator needle; reference pointer; easily connected solid ground (usually found only on larger, more expensive units); fast-response tubes, which require no "breaking-in" time; 115 V line operation (leave in continuous service to eliminate warm-up time, give instant reference and constant pH readings).

Accurate measurements from 0 to 14 pH at 15 to 70°C. are said to be ob-

tained from the standard full-range combination electrode. Several types of combination electrodes, including those for high temperatures (up to 130°C.), are also available.

BUSINESS ITEMS

Lowey to Head Diversey Metal Industries Division

Joseph C. Lowey has been named manager of the Metal Industries Division of *The Diversey Corp.* He will be responsible for developing markets and expanding sales of the firm's chemical cleaners and surface preparation compounds used by the metal industries.

Before joining the company, Mr. Lowey was director of marketing for Clayton Mark & Co., Evanston, Ill.

Spraylat Corp. in New Quarters

Spraylat Corp. is moving its manufacturing plant to larger quarters which will be located at 730 South Columbus Ave., Mt. Vernon, N. Y. The new plant will include improved laboratory facilities to further the development of strippable plastic coatings.

Sel-Rex Names Gerry Smith Sales Engineer

Gerald A. Smith, formerly president of his own company, *Smith Plating Equip. Co.*, Providence, R. I., has joined *Sel-Rex Corp.*, Nutley, N. J., as sales engineer in New England, as part of this company's expansion program in the area. He will work out of the office-laboratory located at 105 Bellows St., Warwick Industrial Pk, Warwick, R. I.

Gerald A. Smith

Mr. Smith has been active in the electroplating equipment and supplies business for over twenty years. After war-time service in the U. S. Army from '42-'46, he was employed by several of the country's leading jewelry manufacturers as plating foreman from 1946-1957. For the next two years, till 1959, he put his practical experience to work as equipment sales engineer and plating consultant, where he gained an industry-wide appreciation of the problems, and their solutions, confronting manufacturers of jewelry and accessories.

Smith is a long-time member of the American Electroplaters' Society, and the Providence Jewelers' Club.

Once you use it you'll Order... Again... and Again... and Again!

Every can filled with a full weight of extra high quality 99.75+% Chromic Acid. Prompt delivery made from ample factory and nearby distributor stocks.

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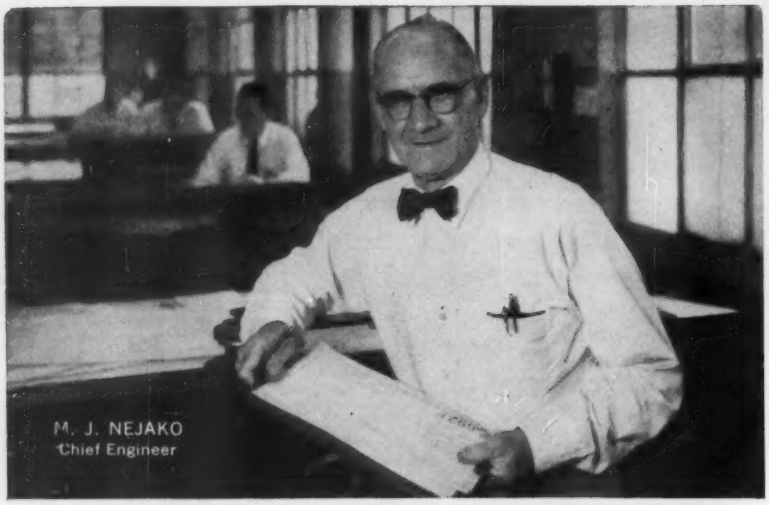
Electroplating Courses

Two short courses for electroplaters and metal finishers will be held from August 20 to Sept. 1, 1961 at the Virginia Polytechnic Institute, Blacksburg, Va.

Course A will be primarily for those who have had no chemistry and only limited plating experience. Course B is for those who wish to pursue more advanced study or a special topic.

Registration will be at 8:00 a.m., August 21, and classes will start at once. The registration fee is $25.00. For further information contact *Dr. N. F. Murphy*, Research Professor, Dept. of Chemical Engineering, Virginia Polytechnic Institute, Blacksburg, Va.



MEET THE PEOPLE BEHIND THE PACKER-MATICS

Many times we have thought, jokingly, of changing our department name from, "Engineering" to "Packer Bank and Trust"... and with good reason, too. Our first move... whenever we are faced with a new engineering problem is to draw on our account... a series of huge engineering files with complete records on every machine, every set of tooling we have ever developed. After 27 years of continual deposits we have a healthy balance to draw on.

And this is a joint account in which all our customers share. They get their dividends in lower engineering costs and proven, practical engineering approaches to their individual tooling or machine requirements. While there is never any reluctance on our part to come up with the novel or new, a look at the bank book to check on interest-bearing deposits and withdrawals always pays off.

When you are in the market for new machinery make sure you are dealing with a manufacturer who can rightfully claim a solvent engineering department.

M. J. Nejako

Faced with a polishing, deburring, buffing or mechanical cleaning problem? Send sample parts, specifications and prints for free test evaluation... or write for free descriptive literature.

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Model No. 14-45 Continuous Rotary

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Model No. 4-5 Rotary Indexing

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PIONEER MANUFACTURERS OF AUTOMATIC POLISHING AND BUFFING MACHINES

Allied Research Moves Fenwick, Appoints Gleisner

Allied Research Products, Inc., Baltimore manufacturers of metal finishing equipment and supplies, has announced that *Roger Fenwick*, former Cleveland representative, has been moved to the Boston territory. Mr. Fenwick will reside in the Boston area, but will work in close contact with the firm's new service laboratory at 625 Bostwick Ave., Bridgeport, Conn. Mr. Fenwick has been associated with the company for a number of years.

At the same time, the firm announced the appointment of *Robert B. Gleisner* as sales representative in Cleveland, with headquarters in the Bulkley Bldg., 1501 Euclid Ave. Prior to joining Allied, Mr. Gleisner was for 11 years a sales representative for the Magnus Chem. Co.

Roger Fenwick

Robert B. Gleisner

Hercules Powder Names Two District Managers

Richard S. Clark has been named district manager in San Francisco and *Joseph G. Jarrell* has been named district manager in the New York office, in the Cellulose and Protein Products Dept. of *Hercules Powder Co.*

Mr. Clark, a graduate of Franklin and Marshall College with a B.S. in chemistry, joined the firm in 1949 as a chemist at the company's research center. He has been engaged in sales activities since 1949. In 1955 he was appointed senior technical representative in New York and became district manager in New York in 1957.

Mr. Jarrell for the past three years has been district manager in San Francisco. He joined the company in 1948 after graduating from the University of Delaware with a B.S. in chemistry. After several years in technical service work in Wilmington, he went to Detroit as senior technical representative and from 1957 to 1958 was district manager in Detroit.

Ceilcote Names Sales Manager

Glenn G. Burnside has been named general sales manager for the *Ceilcote Co.*, Cleveland 9, Ohio. In his new position, he will direct all sales activities for the Duracor Division, construction (field installations), linings, and cement materials for construction and maintenance. He will also co-ordinate the work of the company's research and development laboratories,

Glenn G. Burnside

Quotation Department and manufacturing and relate them to improved customer service.

Burnside, a Ceramic Engineer and graduate of Alfred University, Alfred, N. Y., comes to the firm with over 12 years experience in the field of corrosion protection. He served as sales engineer for the Glascote Division of A. O. Smith Co. for the past five years. Prior to that, he held various administrative and sales positions with A. O. Smith.

Branson Instruments Acquires Circo

Branson Instruments, Inc., Stamford, Conn., has acquired all outstanding stock of *Circo Corp.*, Clark, N. J. Circo will continue to operate at its present location, and no change in management or personnel is contemplated.

Founded in 1923, Circo now employs over 80 people at its New Jersey facility (30,000 sq. ft., with offices and warehouses in all principal U. S. cities. According to company spokesmen, the Circo field organization will be integrated with Branson's staff of sales engineers for maximum customer service.

Three Sales Appointments Announced by Industrial Filter

Bruce Durham has been appointed regional sales manager of *Industrial Filter & Pump Mfg. Co.*, Cicero, Ill. Supervision of sales activities in 14 northeastern states will be his new responsibility. Prior to this new assignment, he represented the company as a service engineer and performed technical services within the research and development section. He is a graduate of Cicero's Morton High School and also attended Morton Junior College. He has been associated with his firm for 6 years.

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Bruce Durham

Charles J. Novotny and *Edward H. King, Jr.* are new sales engineers. The former received his B.S. degree in chemical engineering from Illinois Institute of Technology in 1960, having made the school's dean's honor list and attending on a scholarship. Novotny spent his collegiate summers in research and development at the firm and, upon graduation, was employed in its water and waste treatment division.

Edward King has been employed by the company for over three years in cost engineering and as a corrosive linings salesman. He is a Morton Junior College graduate and is pres-

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ALL DAVIS-K GOLD PLATING SOLUTIONS ARE:

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- Made from U. S. Treasury Gold only
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ACID BRIGHT GOLD PLATING PROCESS

We are fully equipped to reclaim old gold and rhodium solutions.
No charge for small sample plating.
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Call on Davis-K process engineers for help with your special plating problems and installations.

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Edward H. King, Jr.

Charles J. Novotny

ently working toward a B.S. degree.

All three men will be headquartered at the firm's general offices and principal manufacturing facilities.

Phillips Mfg. Appoints George W. Vines

George W. Vines

Phillips Mfg. Co. announces the appointment of *George W. Vines* to fill the position of sales vice-president.

Mr. Vines received his Bachelor of Science degree in Chemical Engineering at The University of Pittsburgh. He has spent 15 years in engineering and sales development work in the structural steel and chemical process industries, and has recently specialized in nuclear equipment and missile launching facilities.

Cawley Named Diversey District Manager

R. L. Cawley has been appointed a district manager in *The Diversey Corporation's* Southern Pacific Division. He will supervise sales and sales promotion in all of Arizona and extreme southern California. He joined the company as a sales representative in 1951.

Snelgrove Joins E. S. Browning

Calvin E. Snelgrove has joined the metal finishing engineering staff of *E. S. Browning Co.*, as chemist and sales engineer. He brings 22 years of metal finishing and chemical background to the firm.

Prior to his present appointment, Mr. Snelgrove held various chemist positions in analytical, research and development, plating consultant, and technical sales management work with well-known firms in the west coast metal finishing industry.

Alvey-Ferguson Appoints Barlett

The *Alvey-Ferguson Co.* announces the appointment of *Stanford J. Barlett* as manager of its Industrial Cleaning and Finishing Equipment Div. with headquarters at Cincinnati 9, Ohio.

Stanford J. Barlett

Mr. Barlett is a graduate mechanical engineer, and brings to the firm 15 years experience in design, manufacture and sale of industrial finishing equipment.

Powertron Has New West Coast Subsidiary

Powertron Ultrasonics Corp. has announced the opening of its new West Coast subsidiary, *Powertron Pacific Corp.*, in Los Angeles, Calif.

The new facility, located at 3277 Wilshire Blvd., will provide creative scientific liaison to customers in 11 Western states in the field of ultrasonic cleaning and liquid level sensing.

Chromalox Announces Two Executive Appointments

Edwin L. Wiegand Co., electric heat equipment manufacturer, has announced the appointment of *Frank B. Knight* to the position of vice-president and *G. Edward Ammerman* to general sales manager of *Chromalox, Inc.*, Murfreesboro, Tenn., a subsidiary.

Mr. Knight, who joined the firm three years ago as general manager, now assumes a more direct responsibility for all company operations.

Prior to his association with the company, Mr. Knight was manager of the Clark Division of the McGraw Edison Corp., Chicago.

Mr. Ammerman will now direct sales activities in connection with all

DIAL TABLE—built to fit your exact requirements.
#55 HEAD—compact, rugged, multi-position polishing and buffing head. Operates right or left.
VERSATILE
"PRODUCTION-PROVEN"
FINISHING EQUIPMENT
from MURRAY-WAY
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Murray-Way offers a complete line of standardized, economical finishing equipment for both large and small shops. In addition, experienced Murray-Way production engineers, working with the finest manufacturing facilities available, will gladly help with your specialized production problems.

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Frank B. Knight

G. Edward Ammerman

the firm's electric heating products. He has been associated with the company for the past seven years as manager of the appliance products division.

Prior to this, he was chief range engineer for the Murray Corp., Scranton, Pa.

Southwestern Engineering Company Names Distributors

Southwestern Engineering Co. of Los Angeles has named the following seven new representatives in the Midwest and East for the sale of its new vibratory finishers:

S. A. Day Mfg. Co., Inc., 1483 Niagara St., Buffalo 13, N. Y.

C. Burwell, Inc., 654 Allwood Road, Clifton, N. J.

John R. Nielsen & Sons, Inc., South Windsor, Conn.

Precision Finishing Co. Sellersville, Pa.

A & B Deburring Co., 1936 Westwood Ave., Cincinnati 14, Ohio.

Abrading Machinery & Supply Co., 2312 W. Wabansia Ave., Chicago 47, Ill.

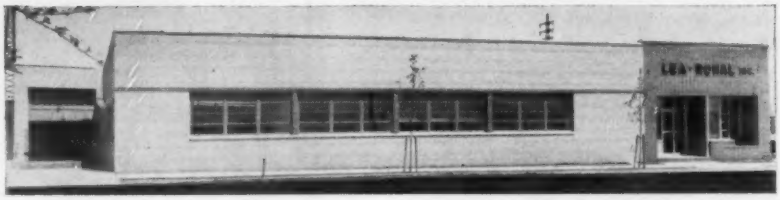
Fortune Metal Finishing Co., 2300 Washington St., Newton Lower Falls, Mass.

Hovey Spray Equipment Moves to Philadelphia Plant

Hovey Spray Equipment Co., distributors of industrial finishing equipment and systems, covering Central and Eastern Pennsylvania, New Jersey and Delaware, has moved into a new plant at 1001 Rising Sun Ave., Philadelphia 40, Pa.

Total floor space in the new one-floor plant is 5,000 square feet, of which 2,500 is allocated for warehouse space, 1,200 as general offices and 1,250 for display and demonstration.

New Plant and Laboratories for Lea-Ronal



Lea-Ronal, Inc., has moved into modern and greatly enlarged quarters at 130-19 180th St., Jamaica, N. Y. The total 10,000 sq. ft. floor area consists of office, testing and analytical laboratories, research and development laboratories, pilot plating unit, precious metal refining unit, solution manufacturing area and storage.

Pilot plating tanks of 50 gallon capacity are available for nickel, copper, brass and silver, whereas smaller units are utilized for gold, gold alloys, silver alloys and precious metals.

R. O. Hull Co. Salesman Wins Salesman's Award

Left to right: A. W. Ardizone, president of Cleveland Sales Executives' Club; John R. Weyls, award winner; Mrs. Weyls; and A. R. Tefft, Enthone resident engineer.

John R. Weyls, sales engineer for *R. O. Hull & Co., Inc.*, Rocky River, Ohio, won the Distinguished Salesman's Award of the Cleveland Sales Executives' Club recently. He was rated highest on the various points established to measure sales performance for a period of one year.

The D.S.A. "Oscar" and its accompanying cash prize were presented to Weyls at the group's Ninth Annual Award Banquet where he and his wife were feted as honored guests.

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Schwab Named by DeSoto

E. R. Schwab has been named product manager, industrial product finishes, by *DeSoto Chemical Coatings, Inc.*, Chicago.

Mr. Schwab joined the firm in 1952 as a chemist, after four years of previous experience in a similar capacity with another firm. In 1954 he was appointed technical director of the Central Resin Division in Chicago Heights, Ill. For the past four years he has served as resin sales manager at that location.

Executive Changes Announced by Chromium Corp. of America

Executive changes have been announced by *Chromium Corporation of America*, one of the country's largest custom plating organizations, operating plants in Waterbury, Chicago and Cleveland.

William J. Zubrisky, formerly executive vice-president, has been elected president and chief executive officer. He succeeds *Donald H. Bissell*, who has been named chairman of the board.

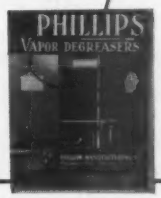
Joseph J. Cassidy, formerly assistant treasurer, has been elected controller.

Both Messrs. Zubrisky and Bissell have been associated with the firm for more than 35 years. They have been instrumental in the growth of industrial chromium plating, and in development of many of today's established engineering practices.

Mr. Zubrisky has his headquarters at the Waterbury, Conn. plant. He has been prominent for many years in both business and civic affairs there and in his home town of New Preston, Conn.

Phillips

the quality name in cleaning and degreasing equipment



OVER 10,000 . . . PHILLIPS degreasers are in use in the U.S.A. All sizes and shapes . . . continuous production or simple manually operated machines. There are many types of degreasers for more uses than most people know . . . Send for free illustrated brochure No. 19.

ULTRASONICS . . . Not every cleaning job requires ultrasonics. Those that do, require experienced application technique for proper selection of transducers, frequencies and solvents . . . PHILLIPS has this experience . . . PLUS a complete selection of ultrasonic units. Check with PHILLIPS before buying. Send for free illustrated brochure No. 23.

TROUBLE with water spots on metal parts after washing? Only PHILLIPS has the new, PATENTED, "TRISEC" solvent dryer. The positive way to dry highly polished articles COMPLETELY STAIN-FREE. Send for free illustrated bulletin No. 24.

Check your Yellow Pages for the nearest PHILLIPS representative.

Phillips MANUFACTURING COMPANY
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DEGREASERS • WASHERS • DRYERS • ULTRASONICS • DEGREASING SOLVENTS

National Ultrasonic Moves to New Facilities

National Ultrasonic Corp. has moved to larger and more modern manufacturing facilities at 95 Park Ave., Nutley, N. J. The new plant will provide approximately 15,000 sq. ft. of manufacturing and 3,000 square feet of office and engineering area.

Additional production equipment is being acquired, providing the firm with complete integrated manufacturing facilities. As far as practical, all components will now be manufactured including metal fabrication and machining.

Allied Research Appoints Cassidy

Allied Research Products, Inc., Baltimore, Md., manufacturers of chemicals, equipment and supplies for metal finishing, has announced the appointment of *Robert B. Cassidy* as sales engineer for the southern territory. From his office, located on Route #8, Greenville, Tennessee, he now serves the states of Tennessee, Alabama, Georgia, Florida, and Mississippi.

Mr. Cassidy brings with him an extensive background and knowledge of the industry, having spent three years as plating superintendent with the Metals Engineering Co. in Greenville, and a number of years in plating

Robert B. Cassidy

plants in Michigan. He has been a member of the A.E.S. for 12 years.

Wilcox Named Blakeslee Detroit Representative

G. S. Blakeslee & Co., Chicago, Ill., has appointed *Arnold L. Wilcox* to the position of sales representative.

Before joining the firm, Mr. Wilcox was associated with Graver Water Conditioning Co., where he was in charge of sales engineering for the state of Michigan. A chemical engineering graduate from South Dakota School of Mines and Technology, Mr. Wilcox will headquarter in Detroit.

Long Named Diversey District Manager

P. H. Long has been named a district manager in *The Diversey Corporation's* Southern Division. He will supervise sales and sales promotion in Virginia, North Carolina, eastern Tennessee and part of Kentucky. He joined the company as a sales representative in 1951.

Firms Announce Proposed Merger

Merger of a Cincinnati research and development firm, *Rad, Inc.* with *Commercial Filters Corp.* of Melrose, Mass., has been recommended by directors of both firms. The merger will be accomplished through an exchange of stock.

Manufacturers' Literature

Finishing Equipment

J. Holland & Sons, Inc., Dept. MF, 475 Keap St., Brooklyn, N. Y.

A new, fully-illustrated, four page brochure describes nineteen different basic types of electroplating, polishing, and spray painting equipment.

Metal Treatments

J. B. Ford Div., Wyandotte Chemicals Corp., Dept. MF, Wyandotte, Mich.

A sectionalized 6-page folder, F-2810, discusses electrocleaning, spray cleaning, soak cleaning, buffing compound removal, and removal of rust from precision parts.

Sheet F-2730 describes a completely water soluble compound, Bufsol, which effectively removes buffing compounds, tripoli and rouges, water dispersable compounds.

A colorful, 4-page folder, F-2374, details how Pre-Fos prevents rusting of in-process steel parts, prepares metals for paint by depositing a fine-grained corrosion-resistant iron phosphate.

Condensed Metal Finishing Guide

Lea Mfg. Co., Dept. MF, 16 Cherry Ave., Waterbury 20, Conn.

This 4-page guide contains condensed information on materials and compounds for such finishing operations as buffing, burring, polishing and satin finishing. There is also a section on additives and specialties for bright plating processes for gold, silver, copper, nickel, cadmium, brass and zinc plating.

Direct Reading Instrument

Beckman Scientific and Process Instruments Div., Dept. MF, 2500 Fullerton Rd., Fullerton, Cal.

A new 16-page descriptive bulletin, 779-B, on the Beckman DB Ultraviolet Spectrophotometer describes major features, outlines specifications, and explains the optical system and operating principles of the double-beam instrument. Numerous curves illustrating the DB's capabilities also are included.

Flat Finishers

Hammond Machinery Builders, Inc., Dept. MF, 1600 Douglas Ave., Kalamazoo, Mich.

A twelve-page illustrated catalog, No. FF-755, is available on the above firm's abrasive belt flat finishers for grinding, polishing, and deburring flat work.

Treatments Prior to Electroplating

MacDermid Inc., Dept. MF, Waterbury 20, Conn.

A new process for preparing aluminum alloys for electroplating which can be used to plate all commonly electroplated metals on all aluminum alloys is fully described in Technical Data Sheet No. 13, a six-page usage and instruction sheet.

Organic Hammer-Finish

Flood & Conklin, Industrial Coatings Div., Dept. MF, 132 Chestnut St., Newark, N. J.

Hammerlac is available in a wide range of colors, and offers good adhesion, depth, bond, fast air drying, and a hiding quality that has been found

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RUBBER AND PLASTIC DRUM LINERS
MONEL, STEEL, COPPER AND TITANIUM ANODE HOOKS
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HAND CHEMICAL PUMPS

New Formula . . . . . .

SILVER-BRITE

FOR USE IN SILVER PLATING SOLUTIONS

PPI has developed a silver brightener under the trade name "Silver-Brite". It is simple to use and now makes it possible for you to deposit .005" of uniform silver plate per hour or .0005" of silver plate in 5 minutes.

Advantages . . . . .

- Uniform and smooth deposit
- Semi-bright plate
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- Will not decompose in use
- Economical in cost per gallon

Silver-Brite is simple to use and will increase your silver plating efficiency. Many companies have used it for plating as high as .040" silver on bearings. Others have used it for thin bright commercial deposits.

PPI Silver-Brite
Stock No. 1-SB

Quantity	Price
1 gallon	$5.00
5 gallon (per gal.)	4.50

PLATING PRODUCTS, Inc.
1509 N. WASHINGTON
KOKOMO, INDIANA

to cover weld defects, porosity, and other surface blemishes on metal products, it is claimed.

Stainless Steel Pipe Fittings

Valve & Fitting Div., Cooper Alloy Corp., Dept. MF, Bloy St. & Ramsey Ave., Hillside, N. J.

A complete line of stainless steel pipe fittings is described in a new 36-page illustrated catalog. Included are screwed fittings, flanges, welding fittings, drainage fittings, hose couplings and other fittings, and sanitary couplings.

The catalog includes outline drawings, tables of principal dimensions, and descriptive notes on specifications and applications.

Drying Ovens

Carl Mayer Corp., Dept. MF, 20800 Center Ridge Rd., Cleveland 16, Ohio.

A new bulletin, DO-61, on drying ovens, features many industrial ovens designed and installed by the above corporation.

Paint Spray Masks

Conforming Matrix Corp., Dept. MF, 780 New York Ave., Toledo 11, Ohio.

A new brochure, Form 7625, describes and illustrates all types of electro-formed metal spray masks for accurately controlled multiple color wet paint decoration and protective coating of mass produced parts. It covers block cut-out plane surface masks, cap type masks for capping raised areas, plug type masks for protecting depressed areas, lip type masks for painting sunken areas, and magnetized masks.

Spray Cleaner and Phosphater

Diversey Corp., Dept. MF, 212 W. Monroe St., Chicago 6, Ill.

No. 519, a spray cleaner for ferrous and non-ferrous alloys, is described in a new bulletin.

Also described is Diverfos F-72, used to apply a thin, uniform iron phosphate coating following the No. 519 rinse.

Disc-Center and Cup Brushes

Osborn Mfg. Co., Dept. MF, 5401 Hamilton Ave., Cleveland 14, Ohio.

A new 4-page brochure details specifications for disc-center (knot type) wire brushes, cup and Keb wire brushes and steel wire scratch brushes.

The booklet's number is 334. It is fully illustrated.

Surface Chemistry

Hughson Chemical Co., Dept. MF, Erie, Pa.

A newsletter, Chemfacts No. 1, is the first of a series that will present comprehensive background information and new product announcements in the areas of surface chemistry—adhesives, coatings, surface treatments and organic chemical specialties.

Resin Products

Shawinigan Resins Corp., Dept. MF, Springfield 1, Mass.

A new 12-page booklet describes the physical properties and suggested uses of the firm's full resin product line. The new Product Reference File, which is an expansion of a shorter work, presents data on polyvinyl formal, polyvinyl butyral, polyvinyl alcohol, and polyvinyl acetate, resins, emulsions and spray-dried powders.

Plate Coils

Platecoil Div., Tranter Mfg., Inc., Dept. MF, Lansing 9, Mich.

A new bulletin describes the adaptability of plate coil heat transfer equipment to special application requirements.

Associations and Societies

AMERICAN ELECTROPLATERS' SOCIETY

Rochester Branch

The Rochester Branch held its last meeting of the season June 5th, at the Rochester Red Men's Club. The meeting was highlighted by an excellent smorgasbord dinner and the election of officers for the coming season. They are as follows:

President — *Charles Fideor.*

1st Vice-President — *Loring Carson.*

2nd Vice-President — *Victor Bonaldi.*

Secretary & Treasurer — *Peter VanDilst.*

Librarian — *Samuel D'Angelo.*

Board of Managers — *Fred Thiem, Frank Beuckman, John Cipolla, Anthony Cottrone, Vern Schaeffer* and *Robert Flint.*

Mr. Schaeffer gave a report on the success of the Branch's 50th Anniversary and Empire State regional con-

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vention, extending personal thanks to all who helped make this affair a great success. After his report, President Cipolla presented Vern with a set of A.E.S. cuff links and tie bar for the outstanding work he did as chairman of this fine meeting.

After the election of officers, Mr. Cipolla gave his farewell address and turned the meeting over to the new president, who went to work appointing several committees for the coming season. Under his leadership, the Rochester Branch should have another very successful season.

Peter VanDilst, Secretary

Newark Branch

First Vice-President *John Kosmos* called the June meeting to order with 40 members and guests present. *Art Carlson*, vice-president of the New York Branch, again visited us.

The first order of business was to discuss the budget as proposed by the National Society. Kosmos and several members explained in detail that the Executive Committee, after much discussion, decided upon the following proposal. That is, we would send our delegates to the convention uninstructed, but with a strong feeling that the Branch was against a deficit budget and against an increase in the dues. After much discussion, the membership agreed to the above proposal.

Ray Abazia then reported that Ideal Plating and Polishing Co. of Newark, N. J., joined the Branch as a sustaining member.

No applications were received. However, the following were elected to membership: *F. L. Durr* of Greene, Pineless and Durr; *T. Geist*, of I.B.M.; *B. C. K. Kraan*, of Carbic-Hoechst Corp.; *A. S. Mustacchio*, of Timco, Inc.; *G. P. Robinson*, of Nuodex Products, Inc.; and *Abert E. Sakavich*, of Metal and Thermit Corp.

The meeting was turned over to *Gene Wagner* for the main activity of the evening, namely, a question and answer period. The panel of experts consisted of Messrs. Di Chiara, Ehrhardt, La Manna, Lux, and Kosmos. Numerous questions were submitted covering a wide variety of items. Attempts were made to answer all questions either directly or by reference to another source.

Gustav Bittrich, Assistant Secretary

Los Angeles Branch

Thirty-year-old Los Angeles Branch and 30-day-old San Diego Branch, the newest in the A.E.S., held a joint meeting at Rodger Young Auditorium, Los Angeles, on the night of June 14 with approximately 100 members, guests and their ladies in attendance.

All officers and directors of San Diego Branch made the 120 mile trip to Los Angeles, some accompanied by their wives, to participate in Los Angeles' last meeting of the 1960-61 fiscal year.

Present from the Border City were President *Harry Steinke* of Electrolab Printed Electronics, Encinitas, Calif.; vice president *George Locke* (and Mrs. Locke) of the Colonial Silver Co., San Diego; secretary *Walter Dorenbusch* of the Braun Corp., San Diego; *James Gregory* of the board of managers, and a group of other members.

Invited by Los Angeles President *Emmett H. Babcock* to address the joint session, Steinke promised a program of close cooperation between the two Southern California branches, to the end that the best available technical speakers can be brought out from the

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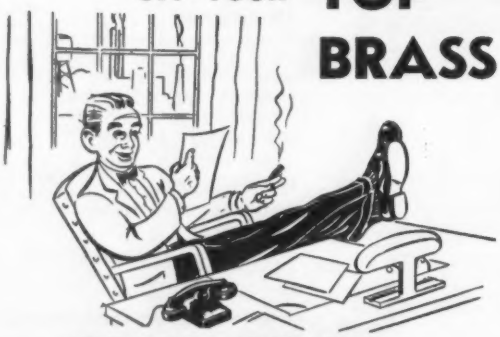

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east and middle-west to address both branches on non-conflicting meeting nights. Another joint meeting, with San Diego as the host, will probably be arranged for later in the year.

Guests included the following: *J. L. Baudrau*, Shipley Co., Los Angeles; *D. W. Terrence*, Graphic Coatings, Los Angeles; *L. H. Vitkin*, Vanquard Plastics, Los Angeles; *T. A. Rohlfsen*, Oakite Products; *W. E. Lawrence*, Raymr Mfg. Co.; *R. K. Foster, Harry Steinke, Joseph Gregory, James Gregory*, and Mr. and Mrs. *George Locke*, all of San Diego; *Leon Conn*, Chemtron Research, Glendale; and *B. W. Wilson*, Graphic Coatings, Los Angeles.

The speaker of the evening was *Gene H. Weiner*, vice president of Chemtron Research & Development Corp., Glendale, Calif., who presented a talk on new electronic packages and components from electroless plating solutions. He used a series of photographs and blackboard diagrams to illustrate components and wiring techniques which were touched upon in his talk.

Weiner's presentation was compactly condensed into a 20-minute discussion which was followed by a question-and-answer period that lasted for nearly an hour.

The Branch holds no monthly meetings in July and August. The next meeting is scheduled for Wednesday, Sept. 13, in Rodger Young Auditorium, Los Angeles.

British Columbia Branch

The last regular meeting of the 1960-61 season was held at the Lougheed Hotel, North Burnaby on May 26th, with 28 members present.

The reading of the minutes and treasurer's report was followed by the election of officers.

President — *Ralph Wolloschuk.*
1st vice-president — *Jack Stoneberg.*
2nd vice-president — *Gerald Ames.*
Secretary — *Hugh Roberts.*
Treasurer — *Jim Saimoto.*
Program director & librarian — *Bill Marquardt.*
Branch research finance chairman — *Gordon Smith.*
Board of managers — *Antonius Vriends, Nelson Shepherd.*
Claus Schlossareck, Secy.

Blue Ridge Branch

On June 3, 1961 members and guests of the Branch visited the Kure Beach-Harbor Island Testing Stations of the International Nickel Co. near Wrightsville Beach, N. C. Several members and guests from North Carolina and Virginia made the trip to the eastern coast of the state for this tour. Several of the members brought their families for a week-end of fishing, beachcombing, sightseeing and relaxation.

Those taking the tour met at the Harbor Island Laboratory at 9:00 A.M. After introductions to *Dr. T. P. May, Dr. C. H. Sample* and *Vic Taylor*, host for the day, the group was briefed on the work being done at the Harbor Island Laboratory and the Kure Beach atmospheric test site. The group was then divided and conducted through the laboratory. On the tour the various methods for testing the corrosion resistance and rate of corrosion of various metals, metal alloys and nonmetals were pointed out. This phase of the tour ended about 11:30 A.M.

The group then drove to Carolina Beach where they ate lunch as guests of the company. After lunch the tour of the Kure Beach site was held. Dr. Sample and Mr. Taylor very informa-

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tively pointed out, and discussed the electroplated panels being tested. The tour was not hurried and our hosts very thoroughly answered the many questions asked them. The resistance to corrosion of various thickness of nickel, duplex nickels, chrome thicknesses and duplex chrome systems were observed.

After completing the tour at 4:00 P.M. the members expressed their thanks to our host for a very interesting and informative tour and an enjoyable day.

Donald H. McGee,
Secretary

SOCIETY OF VACUUM COATERS

Anyone interested in presenting a technical paper before the next Conference of Vacuum Coaters which will be held at the Sheraton-Cleveland Hotel in Cleveland on March 6-7, 1962 should contact Burton Hineline, Xerox Corporation, 282 Hollenbeck St., Rochester, N. Y. before September 1st.

At the present time papers that have been scheduled are: Advanced Flow-Coating Techniques; New Spray Equipment and Applications; Cost Estimating of Vacuum Metallizing; Metallizing of Polyolefins; Filament Firing Techniques; Selection of Plastics for Metallizing; Surface Preparation of Metals for Metallizing; Missiles & Space Applications for Vacuum Metallizing; Vacuum Metallizing in the Optics Industry; Re-Solderable Vacuum Coatings; Infra-Red Reflective Vacuum Coatings.

Further information about the 5th Annual Technical Conference will appear in future issues.

AMERICAN ZINC INSTITUTE, INC.

The appointment of *Louis Kettler* as research engineer to the staff of American Zinc Institute-Lead Industries Association expanded research program was announced recently. His activities will include the administration of research projects, with special emphasis on cost studies, project initiation and monitoring, and technical reports.

Before joining the research staff, Kettler served as project engineer in

Louis Kettler

charge of research and development with Continental Copper & Steel Industries, Inc., New York City. Prior to this, he was technical manager, special products, with Consultants & Designers, Inc., New York City.

Kettler is a member of the American Society for Metals, the National Association of Corrosion Engineers, and the Society of Plastics Engineers. He

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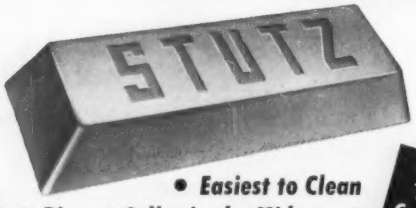

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is a Professional Engineer, licensed in the State of New York. He studied engineering at New York University.

AMERICAN SOCIETY FOR METALS

A record number of ten American technical societies and trade associations, with a combined membership of more than 100,000, will present 62 half-day technical sessions at the Detroit Metal Show in participation with the sponsoring *ASM*, October 23-27. The technical program will run concurrently with presentation of ASM's educational exhibit on materials and materials processing at Cobo Hall.

AMERICAN SOCIETY FOR TESTING MATERIALS

A. Kenneth Graham and *Henry L. Pinkerton*, president and chemical engineer, respectively, *Graham, Savage and Associates, Inc.*, Jenkintown, Pa., have received the Sam Tour Award at the Awards Luncheon, Chalfonte-Haddon Hall, during the 64th Annual Meeting of the A.S.T.M. at Atlantic City, N. J. This annual award is given to the author or authors of a technical paper, published by the Society, of outstanding merit in the field of improvements and evaluation of corrosion testing methods.

Dr. Graham and Mr. Pinkerton received the award for their paper on "Standardizing the Preparation of Electrodeposits on Test Panels for Corrosion Testing," which was published in *Proceedings, 59*, (1959).

ALUMINIUM DEVELOPMENT ASSOCIATION

The Association, with the University of Nottingham Department of Metallurgy, is organizing a residential conference at the University from Sept. 12 to 14, 1961. There will be technical sessions on the afternoon of Tuesday, Sept. 12, and morning and afternoon sessions on Wednesday. The conference will end officially after breakfast on Thursday.

The aim of this conference is twofold:

To provide an opportunity for anodizers, users of anodized aluminum, and the industry generally to discuss the latest technical developments.

To give research workers in this field an opportunity to discuss the fundamental aspects of their subject.

Fifteen papers, by British and foreign authors, will be presented. They will be grouped into six sessions under separate headings, and to make the best use of time available will be printed and distributed well before the conference; in this way the appropriate papers can be briefly introduced at each session and the rest of the time devoted to discussion and authors' replies.

Accommodations will be in Cripps Hall, a new University building, and the all-in charge for the Conference is 5 guineas; for two nights only — 4 guineas; and for meals only — 3 guineas for each person. There is limited accommodation for members of the Conference who wish to bring their wives.

Forms of application, containing full details of fees, times, etc., can be obtained from The Secretary, The Aluminium Development Assn., 33, Grosvenor Street, London, W.1. Early application is desirable as there may have to be some limitation on numbers.

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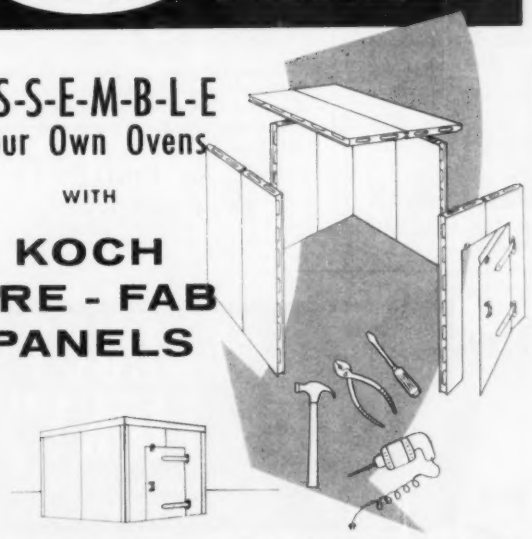

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NEWS FROM CALIFORNIA

Three members of Southern California's younger group of research engineers, all in the under-30 age bracket, have banded together to form a new organization devoted to providing analytical services to the printed circuit and allied phases of the plating and electronics industries.

Name of the new firm is Chemtron Research & Development Corp. The founders and officers are: President, *Leo Cann*, formerly senior research engineer, Ramo-Woolridge Corp., Northridge, Calif.; vice-president, *Gene H. Weiner*, who recently resigned as western technical representative for Shipley Co., Inc., Wellesley, Mass.; and secretary-treasurer, *Don E. Baudrand*, owner, Baudrand Laboratories, Los Angeles.

The new organization has established administration and laboratory facilities at 1840 Dana St., Glendale, Calif. The laboratory has been equipped for analytical work, including testing of plating solutions, with emphasis on the needs of the printed circuit and electronics field.

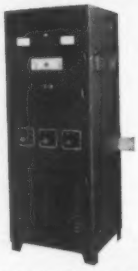
In addition to its laboratory services, the firm will serve as manufacturer's representative for a line of plastics, including epoxies, polyurethanes and polyesters, produced by Vanguard Plastics of Los Angeles. It will also distribute a line of high and low coercive coatings for aluminum and magnesium discs and drums for computer memories.

While Baudrand serves the new firm as secretary-treasurer, he will continue to operate the Baudrand Laboratories at 791 E. 15th St., Los Angeles. Some of the Baudrand lab facilities will be used by Chemtron in the early stages of its operation. *Glenn Mallory*, until recently a technical service engineer with L. H. Butcher Co., has been named Chemtron's director of analytical services.

The proudest day in the plating career of *Ted Goodman*, owner of Michael-Rand Plating Co., Inc., came on July 10 when he held open house for the plating, electronics, and missile industries in his new $125,000 finishing plant at 16760 Schoenborn St., Sepulveda, Calif. Goodman established the firm six years ago as a two-man shop in facilities that were little larger than a good-sized garage in Van Nuys, Calif. Two years later a larger plant was opened at 16018 Strathern Way, Van Nuys.

After six years in business, Goodman finds himself occupying an 18,000 sq. ft. plant in Sepulveda in the western section of the San Fernando Valley. The plant can handle 28 different processes, including all types of

Clinton



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The plant operates on a 24 hour basis with a staff of approximately 40. Mr. Goodman is president and general manager; *E. M. Wheeler*, sales manager, and *E. E. Nance*, shop superintendent.

Los Angeles City College, in cooperation with the Los Angeles Paint, Varnish & Lacquer Association and the Los Angeles Paint & Varnish Production Club, will offer evening courses for employees of the paint industry, and other qualified individuals, starting September 18.

Two courses will be available. A general paint technology course, in two units, will include a study of raw materials, pigments, resins, oils, solvents, and driers, as well as principles of formulation and basic calculations of the industry. This class will be held on Mondays from 7 to 9 p.m., beginning Sept. 18, with *Roy Fredericks* as the instructor.

A general paint technology laboratory course for students enrolled in Paint Technology II will be offered on Thursdays from 7 to 10 p.m., with *Fred Fox* as the instructor.

George H. Peters, formerly on the sales staff of the Great Western Chem. Co. of San Francisco and Los Angeles, has been named a process engineer for cleaning and conversion coatings for the Alert Supply Co., Los Angeles.

The National Association of Corrosion Engineers has announced the dates for its Western Regional Conference as October 4, 5 and 6 at the Benson Hotel in Portland, Ore. *Donald D. McGregor* of the U. S. Engineers is general arrangements chairman, and *William H. Kipp, Jr.*, of Waterworks Supply Co., local chairman. Inspection field trips will be made under the direction of *John Malmquest* of the W. P. Fuller Co., Portland.

Bronson Instruments, distributors of ultrasonic cleaners, ultrasonic thickness gauges, and flaw detectors, recently moved into a new building at 5925 Novle Ave., Van Nuys, Calif.

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CALENDAR

Aug. 19: Annual Picnic, Cincinnati Branch AES, "The Farm", Anderson Ferry Road, Cincinnati, Ohio

Sept. 5-8: 11th National Chemical Exposition, Chicago Amphitheater, Chicago, Ill.

Oct. 1-5: Fall Meeting, The Electrochemical Society, Hotel Statler, Detroit, Mich.

Oct. 16-19: 2nd International Congress on Vacuum Technology, Sheraton Park Hotel, Washington, D. C.

Oct. 23-27: 43rd National Metal Show and Congress, American Society for Metals, Cobo Hall, Detroit, Mich.

Nov. 2-4: 39th Annual Meeting, Federation of Societies for Paint Technology, Washington, D. C.

Dec. 1-2: Annual Educational Meeting and Banquet, Detroit Branch A.E.S., Statler-Hilton Hotel, Detroit, Mich.

Dec. 15-16: Annual Educational Session and Banquet, Newark Branch AES, Robert Treat Hotel, Newark, N. J.

Jan. 20: Annual Meeting, Grand Rapids Branch AES, Pantlind Hotel, Grand Rapids, Mich.

Jan. 27: Annual Educational Meeting and Banquet, Chicago Branch AES, Conrad Hilton Hotel, Chicago, Ill.

Jan. 30-Feb. 2: 18th Annual Technical Conference, Society of Plastics Engineers, Penn-Sheraton Hotel, Pittsburgh, Pa.

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1—Wagner 2500 amp. 9 v. Remote Control
2—Udylite 1500/750 amp. 12/24 v.
7—G.E. 500 Amp. 6 V. Basic.

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1—18" x 36" Abbott Rubber Lined M.D.
2—Roto-Finish Tumbling Barrels DW-60-36-2 comp. rubber lined, M.D.
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Large assortment of Baird, Crown, Globe, Henderson motor driven furnished with steel, wood or lined barrel.
1—Roto Finish Unloading chute

MISCELLANEOUS

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Clair Flat Surface Model #202
U. S. Variable Speed 5 HP — four speeds
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Fibreglass tanks & exhaust systems, Degreasers, Cathode Rod Agitators, Pumps, Shakers, Chip Bins, Hoists, Flexible Shafts, Tanks — all linings, Anodes, Chemicals, Compounds, Ovens, Centrifugal Dryers, Spray Booths, etc., etc.

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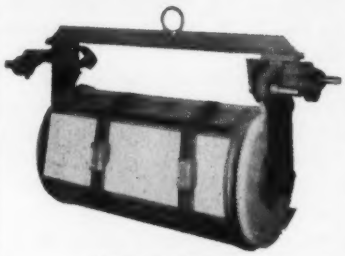

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333	30	G. E.
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698	47.5	Elec. Prod.
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750/375	6/12	Excell-All
845	47.3	Elec. Prod.
940	32	Elec. Prod.
1000/500	6/12	Eager
1000/500	12/24	H-V-W
1500	15	Star
1500	30/50	Century
1500	40/65	G. E.
1500	65	Westinghouse
1500	70	Century
2000	6	Eager
6000/3000	6/12	Elec. Prod.
6000/3000	6/12	Chandeysson
6000/3000	12/24	Chandeysson
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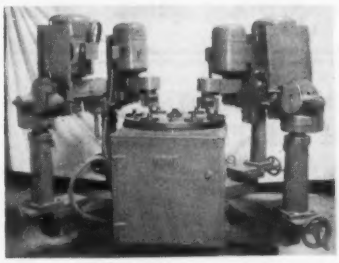

30" automatic indexing table — variable speed — six spindle — heavy duty

4—5-HP completely adjustable heads. Heads are an integral part of machine.

5—Starters for each head and table motors.

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Machine has been fully reconditioned — new bearings installed — worn parts replaced in table.

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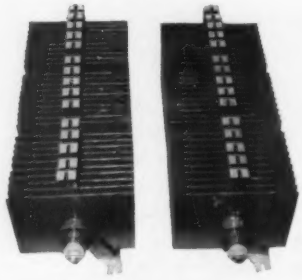

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Primary qualification is a minimum of 10 years direct experience in this field. Knowledge of chemistry is desirable but not absolutely required. Analytical laboratory control service is available.

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Box 116, Saugerties, N. Y.

Dow Chemical Co., The (Saran Lined Pipe) 26
2415 Burdette Ave., Ferndale 20, Mich.

Dresser Electric Co. 34
2705 Wight St., Detroit 7, Mich.

DuBois Chemicals, Inc. .....
Broadway at Seventh, Cincinnati 2, Ohio

DuPont de Nemours & Co., Inc., E. I. 36, 37
Wilmington 98, Del.

Dura-Brite Chemical Products, Inc. 29
P. O. Box 82, Farmingdale, L. I., N. Y.

Electro-Glo Co. .....
625 S. Kolmar Ave., Chicago 24, Ill.

Enjay Chemical Co., Div. of Humble Oil & Refining Co. .....
15 W. 51st St., New York 19, N. Y.

Enthone, Inc. 3
442 Elm St., New Haven 8, Conn.

Federated Electro-Chemicals Dept., American Smelting & Refining Co. 21
120 Broadway, New York 5, N. Y.

Formax Mfg. Corp. 98
3171 Bellevue, Detroit 7, Mich.

Frank, Paul .....
118 E. 28th St., New York 16, N. Y.

Gumm Chemical Co., Inc., Frederick 39
538-542 Forest St., Kearny, N. J.

H & S Equipment Sales Co., Div. J. Holland & Sons, Inc. .....
Keap St., Brooklyn, N. Y.

Hamilton Emery & Corundum Co. 102
Chester, Mass.

Hammond Machinery Builders, Inc. .....
1600 Douglas Ave., Kalamazoo 54, Mich.

Hammond Solvents Recovery Service .....
241 Brunswick St., Hammond, Ind.

Handy & Harman .....
850 Third Ave., New York 22, N. Y.

Hanson-Van Winkle-Munning Co. 6, 7, 30, 83
Matawan, N. J.

Hardwood Line Mfg. Co. 103
2022 N. California Ave., Chicago 47, Ill.

Harshaw Chemical Co., The 5
1945 E. 97th St., Cleveland 6, Ohio

Heatbath Corp. .....
Springfield 1, Mass.

Heil Process Equipment Corp. .....
12914 Elmwood Ave., Cleveland 11, Ohio

Hooker Chemical Corp. 10
1308 Union St., Niagara Falls, N. Y.

Hubbard-Hall Chemical Co. .....
28 Benedict St., Waterbury 20, Conn.

Hull & Co., Inc., R. O. .....
1302 Parsons Ct., Rocky River 16, Ohio

Ideal Chemical Co. 105
1499 Dean Dr., So. Euclid 21, Ohio

Illinois Water Treatment Co. .....
840 Cedar St., Rockford, Ill.

Imperial Industries, Inc. .....
4436 Walker Ave., Wayne, Mich.

Industrial Filter & Pump Mfg. Co. 18
5906 Ogden Ave., Cicero 50, Ill.

International Nickel Co., Inc., The .....
67 Wall St., New York 5, N. Y.

Jelco Finishing Equipment Co. .....
153 E. 26th St., New York 10, N. Y.

Kelite Corp. .....
81 Industrial Rd., Berkeley Heights, N. J.

Koch Sons, Inc., George 101
10 S. 11th Ave., Evansville 4, Ind.

Kocour Co. 32
4800 So. St. Louis Ave., Chicago 32, Ill.

Kosmos Electro-Finishing Research, Inc. .....
140 Liberty St., Hackensack, N. J.

Kushner, Dr. Joseph B. 103
621 S. Norman, Evansville 14, Ind.

Lasalco, Inc. 9
2820-38 LaSalle St., St. Louis 4, Mo.

Lea Mfg. Co. 75
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Lea-Michigan, Inc. .....
14459 Wildemere Ave., Detroit 38, Mich.

Lea Products Co. 32
996 De Boullion St., Montreal 15, Quebec, Can.

Lea-Ronal, Inc. 76
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L'Hommedieu & Sons Co., Chas. F. .....
4521 Ogden Ave., Chicago 23, Ill.

Lindale Equipment & Supply Corp. 104
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Macarr, Inc. .....
4360 Bullard Ave., Bronx 66, N. Y.

MacDermid Inc. ..... Back Cover
Waterbury 20, Conn.

Magnus Chemical Co., Inc. 87
11 South Ave., Garwood, N. J.

Manhattan Rubber Div., Raybestos-Manhattan, Inc. .....
6 Willett St., Passaic, N. J.

Matchless Metal Polish Co. .....
840 W. 49th Pl., Chicago, Ill.

Meaker Co., The .....
Sub. of Sel-Rex Corp., Nutley 10, N. J.

Mearl Corp., The .....
41 E. 42nd St., New York 17, N. Y.

Metal & Thermit Corp. 33, 42
Rahway, N. J.

Michigan Buff Co., Inc. 105
3503 Gaylord Ave., Detroit 12, Mich.

Mitchell-Bradford Chemical Co. 34
Wampus Lane, Milford, Conn.

Motor Repair & Mfg. Co., The 104
1555 Hamilton Ave., Cleveland 14, Ohio

Munning & Munning, Inc. .....
202-208 Emmett St., Newark 5, N. J.

Murray-Way Corp. 93
P. O. Box 180, Maple Rd. E., Birmingham, Mich.

National Plastics & Plating Supply Co. 38
Box 34, Terryville, Conn.

New Holland Machine Co. .....
New Holland, Pa.

N. J. Thermex Co., Inc. .....
535 Bergen St., Harrison, N. J.

Northwest Chemical Co. 14
9310 Roselawn Ave., Detroit 4, Mich.

Nuodex Products Co. 40
Box 242, Elizabeth, N. J.

Oakite Products, Inc. .....
18 Rector St., New York 6, N. Y.

Packer Machine Co. 90
456 Center St., Meriden, Conn.

Park Equipment & Supply Corp. 105
604 - 20th St., Brooklyn 18, N. Y.

Pesco Plating Equipment Corp. 105
75 Wythe Ave., Brooklyn 11, N. Y.

Pfizer & Co., Inc., Chas. 20
630 Flushing Ave., Brooklyn 6, N. Y.

Phelps Dodge Refining Corp. .....
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Phillips Manufacturing Co. 95
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Pittsburgh Plate Glass Co., Chemical Div. .....
One Gateway Center, Pittsburgh 22, Pa.

Plating Products, Inc. 96
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Plating Service & Equipment Corp. .....
1401 Conner, Detroit 15, Mich.

Randolph Proaucts Co. .....
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Ransburg Electro-Coating Corp. 85
3939 W. 56th St., Indianapolis 23, Ind.

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Raybestos-Manhattan, Inc. Manhattan Rubber Div. .....
Passaic, N. J.

Reading Industrial Equipment Co., Inc. .....
P. O. Box 765, Reading, Pa.

Reliable Industrial Equipment Co., Inc. 106
633 Richmond St. N.W., Grand Rapids 4, Mich.

Rona Pearl Corp., Div. Rona Laboratories, Inc. .....
E. 21st & E. 22nd Sts., Bayonne 3, N. J.

Seaway Nickel Corp. .....
101 East Ave., No. Tonawanda, N. Y.

Sel-Rex Corp. ..... Inside Back Cover
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Service Research & Development Co., Inc. 100
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2286 Babylon Turnpike, Merrick, L. I., N. Y.

Singleton Co., The 4
11720 Berea Rd., Cleveland 11, Ohio

Sommers Bros. Mfg. Co. 102
3439 No. Broadway, St. Louis 7, Mo.

Stevens, Inc., Frederic B. 15
1808 - 18th St., Detroit 16, Mich.

Stutz Co., The 12, 100
4430 W. Carroll Ave., Chicago 24, Ill.

Technic, Inc. 41
88 Spectacle St., Cranston, R. I.

Titanium Products Corp. 103
9301 French Rd., Detroit 13, Mich.

True Brite Chemical Products Co. 98
P. O. Box 31, Oakville, Conn.

Turco Products, Inc. .....
24600 So. Main, Wilmington, Calif.

Twin City Testing Corp. .....
P. O. Box 95, Tonawanda, N. Y.

Udylite Corp., The 23, 24, 25, 27
Detroit 11, Mich.

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53-15 37th Ave., Woodside 77, N. Y.

Unitron Instrument Co., Microscope Sales Div. 86
66 Needham St., Newton Highlands 61, Mass.

Universal Vibrating Screen Co. .....
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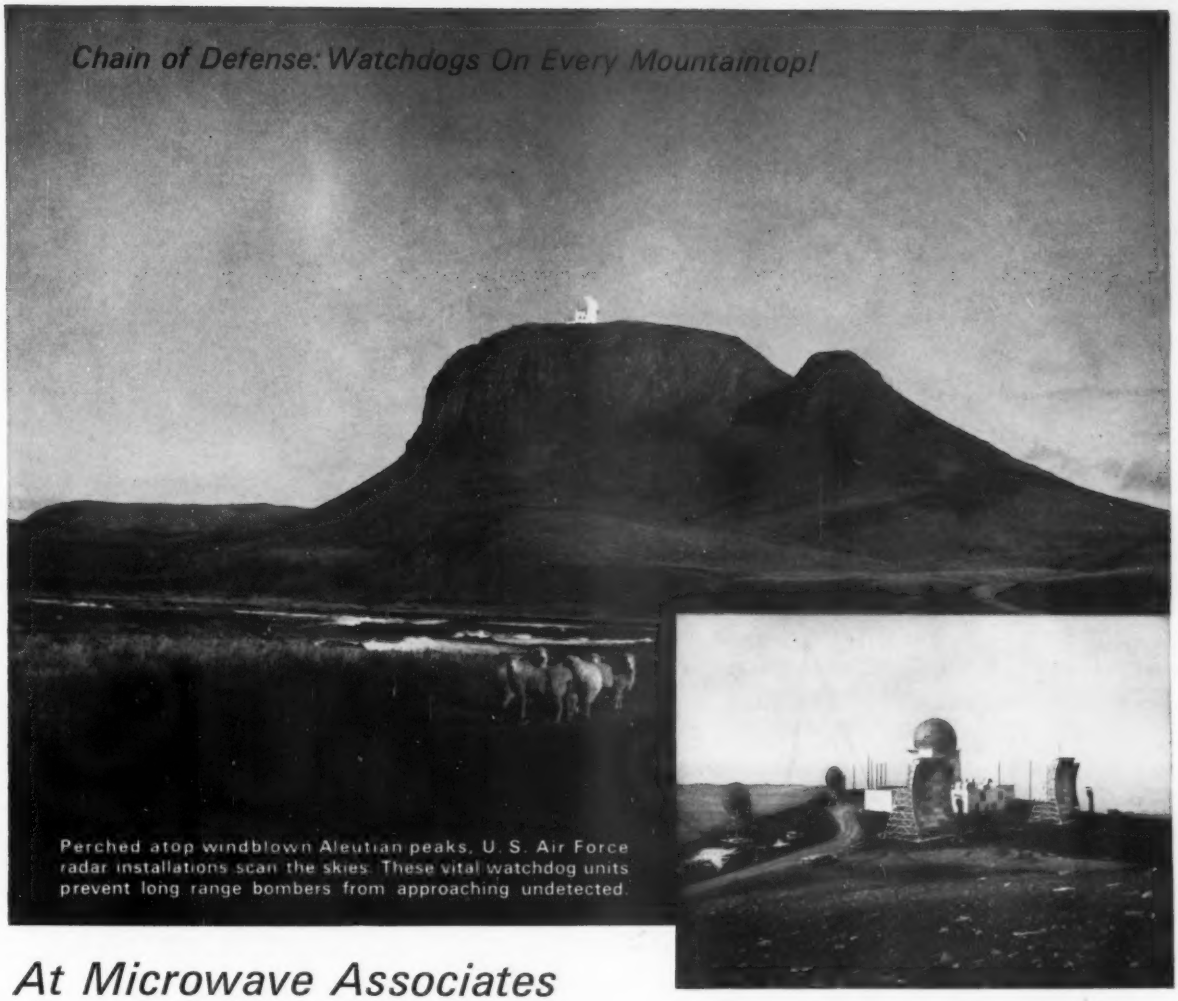
1313 Hawthorne Ave., Minneapolis, Minn.

Virginia-Carolina Chemical Corp. .....
401 E. Main St., Richmond 8, Va.

Worthy Products Co. 104
Box 1432, Boca Raton, Fla.

Wyandotte Chemicals Corp. 31
Wyandotte, Mich.

Zialite Corp. .....
92 Grove St., Worcester 5, Mass.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